US009356278B2

(12) United States Patent
Suzuki

(10) **Patent No.: US 9,356,278 B2**
(45) **Date of Patent: May 31, 2016**

(54) **BATTERY PACK**

(75) Inventor: **Toru Suzuki**, Kanagawa (JP)

(73) Assignee: **NEC Energy Devices, Ltd.**, Kanagawa (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 181 days.

(21) Appl. No.: **14/007,240**

(22) PCT Filed: **Sep. 7, 2011**

(86) PCT No.: **PCT/JP2011/005031**
§ 371 (c)(1),
(2), (4) Date: **Sep. 24, 2013**

(87) PCT Pub. No.: **WO2012/131801**
PCT Pub. Date: **Oct. 4, 2012**

(65) **Prior Publication Data**

US 2014/0023909 A1 Jan. 23, 2014

(30) **Foreign Application Priority Data**

Mar. 31, 2011 (JP) 2011-078335
Mar. 31, 2011 (JP) 2011-078336
Mar. 31, 2011 (JP) 2011-078337
Mar. 31, 2011 (JP) 2011-078338
Mar. 31, 2011 (JP) 2011-078339
Mar. 31, 2011 (JP) 2011-078340
Mar. 31, 2011 (JP) 2011-078344

(51) **Int. Cl.**
H01M 2/00 (2006.01)
H01M 2/20 (2006.01)
H01M 2/10 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***H01M 2/206*** (2013.01); ***H01M 2/1077*** (2013.01); *H01M 2/021* (2013.01); *H01M 2/0212* (2013.01); *H01M 10/425* (2013.01)

(58) **Field of Classification Search**
CPC . H01M 10/425; H01M 2/021; H01M 2/0212; H01M 2/1077; H01M 2/206
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

2003/0082445 A1 5/2003 Smith et al.
2003/0129483 A1 7/2003 Gross
(Continued)

FOREIGN PATENT DOCUMENTS

CN 101517784 A 7/2007
CN 101043092 A 9/2007
(Continued)

OTHER PUBLICATIONS

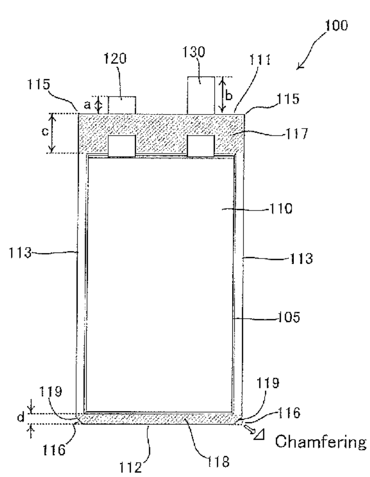
Office Action mailed Jan. 28, 2015 in related Japanese Application No. 2011-078336 with partial English-language translation (4 pgs.).
(Continued)

Primary Examiner — Patrick Ryan
Assistant Examiner — Ben Lewis
(74) *Attorney, Agent, or Firm* — Foley & Lardner LLP

(57) **ABSTRACT**

In order to provide a battery pack that can be produced highly efficiently and contribute to an improvement in productivity, a battery pack of the present invention includes: a plurality of unit batteries **100** that include a positive-electrode pulled-out tab **120** and a negative-electrode pulled-out tab **130**; and a board **300** on which pulled-out tab connection sections are formed to connect the pulled-out tabs of different polarities of adjacent unit batteries **100**.

13 Claims, 26 Drawing Sheets



(51) **Int. Cl.**

H01M 2/02	(2006.01)
H01M 10/42	(2006.01)

(56) **References Cited**

U.S. PATENT DOCUMENTS

2003/0146734 A1	8/2003	Kozu et al.		
2005/0140338 A1*	6/2005	Kim	H01M 2/202 320/150	
2005/0282069 A1	12/2005	Kim et al.		
2007/0081356 A1	4/2007	Lee et al.		
2007/0231682 A1	10/2007	Aoyama et al.		
2008/0124617 A1	5/2008	Bjork		
2009/0311581 A1	12/2009	Park et al.		
2009/0323293 A1	12/2009	Koetting et al.		
2010/0136420 A1	6/2010	Shin et al.		
2011/0135970 A1*	6/2011	Han	H01M 2/204 429/7	
2012/0156527 A1*	6/2012	Kataoka	H01M 2/204 429/7	

FOREIGN PATENT DOCUMENTS

CN	101305397 A	11/2008		
DE	10 2009 005 124 A1	7/2010		
EP	1 271 672 A1	1/2003		
EP	1 845 570 A1	10/2007		
EP	2 131 413	12/2009		
EP	2 299 521 A2	3/2011		
JP	2001-035538 A	2/2001		
JP	2001-202931 A	7/2001		
JP	2002-144047 A	5/2002		
JP	2002-165385 A	6/2002		
JP	2002-260600 A	9/2002		
JP	2003-007262 A	1/2003		
JP	2004-179141 A	6/2004		
JP	2005-011855 A	1/2005		
JP	2005-222701 A	8/2005		
JP	2005-347156 A	12/2005		
JP	2006-164579 A	6/2006		
JP	2006-164895 A	6/2006		
JP	2006-244755 A	9/2006		
JP	2007-087875 A	4/2007		
JP	2007-265945 A	10/2007		
JP	2008-091206 A	4/2008		
JP	2008-153204 A	7/2008		
JP	2008-305774 A	12/2008		
JP	2009-163932 A	7/2009		
JP	2009-176690 A	8/2009		
JP	2009-259581 A	11/2009		
JP	2009-272048 A	11/2009		
JP	2010-503971 A	2/2010		
JP	2010-092598 A	4/2010		
JP	2010-170799 A	8/2010		
JP	2010-170799 A	8/2010		
JP	2010-287568	12/2010		
JP	WO 2011/027817 A1 *	3/2011		H01M 2/10
JP	2011-181369 A	9/2011		
KR	10-2004-0022713 A	3/2004		
WO	WO 2006/067903 A1	6/2006		
WO	WO 2008/035873 A1	3/2008		
WO	WO-2008/102571 A1	8/2008		
WO	WO-2010/131780 A1	11/2010		
WO	WO 2011/027817 A1	3/2011		

OTHER PUBLICATIONS

Office Action mailed Feb. 28, 2015 in related Chinese Application No. 201180069786.7 with English-language translation (16 pgs.).

Office Action mailed Feb. 25, 2015 in related Chinese Application No. 201180069789.0 with English-language translation (18 pgs.).

Office Action mailed Jan. 27, 2015 in related Chinese Application No. 201110297042.2 with partial English-language translation (5 pgs.).

Extended European Search Report mailed Jan. 5, 2015 in related European Application No. 11862435.2 (5 pgs.).

Notice of Rejection issued in Japanese Application No. 2011-078335 dated Nov. 5, 2014, with English translation.

Notice of Rejection issued in Japanese Application No. 2011-078336 dated Nov. 5, 2014, with English translation.

Notice of Rejection issued in Japanese Application No. 2011-078337 dated Nov. 12, 2014, with English translation.

Notice of Rejection issued in Japanese Application No. 2011-078338 dated Nov. 12, 2014, with English translation.

Notice of Rejection issued in Japanese Application No. 2011-078339 dated Nov. 7, 2014, with English translation.

Notice of Rejection issued in Japanese Application No. 2011-078340 dated Nov. 12, 2014, with English translation.

Notice of Rejection issued in Japanese Application No. 2011-078344 dated Nov. 12, 2014, with English translation.

Office Action mailed Apr. 1, 2015 in related Chinese application No. 201180069788.6 with English-language translation (11 pgs.).

Extended European Search Report issued in European Application No. 11 862 421.2 dated Sep. 4, 2014.

Extended European Search Report issued in European Application No. 11 862 493.1 dated Aug. 20, 2014.

Second Office Action and Search Report issued in Chinese Application No. 201110297042.2 dated Aug. 12, 2014, with English translation.

Non-final Office Action mailed Jul. 8, 2015 in related U.S. Appl. No. 14/007,591 (9 pgs.).

Non-final Office Action mailed Jul. 16, 2015 in related U.S. Appl. No. 14/007,606 (9 pgs.).

International Seach Report in PCT/JP2011/005031 dated Nov. 29, 2011.

International Search Report in PCT/JP2011/005032 dated Dec. 6, 2011.

International Search Report in PCT/JP2011/005033 dated Nov. 8, 2011.

International Search Report in PCT/JP2011/005034 dated Dec. 20, 2011.

Extended European Search Report issued in European Application No. 11 862 253.9 dated Oct. 31, 2014.

Notice of Rejection issued in corresponding Japanese Application No. 2011-078342 dated Nov. 19, 2014, with English translation.

Final Office Action mailed Jan. 20, 2016 in co-pending U.S. Appl. No. 14/008,417 (9 pgs.).

Final Office Action mailed Jan. 29, 2016 in co-pending U.S. Appl. No. 14/007,606 (10 pgs.).

Non-final Office Action mailed Apr. 8, 2016 in related U.S. Appl. No. 14/007,591 (13 pgs.).

* cited by examiner

FIG.1

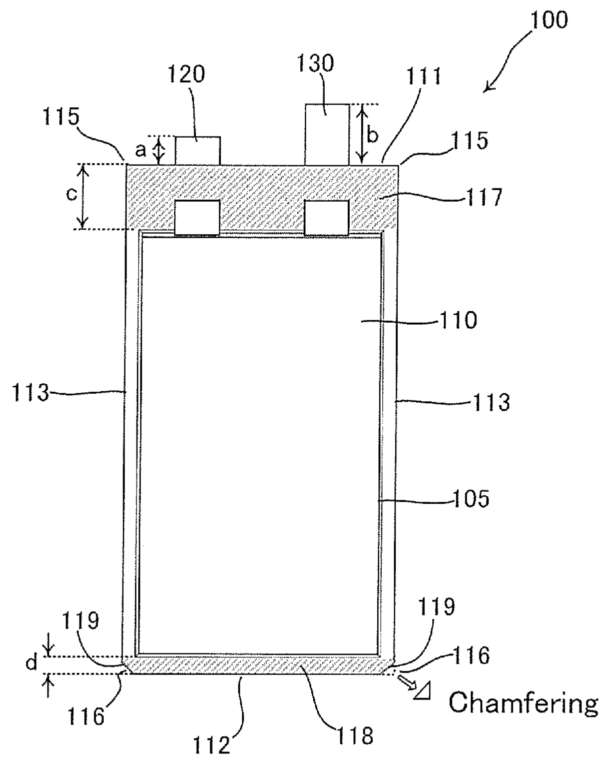

100
120
130
111
115
a
b
115
c
117
110
113
113
105
119
119
d
116
116
Chamfering
112
118

FIG.2

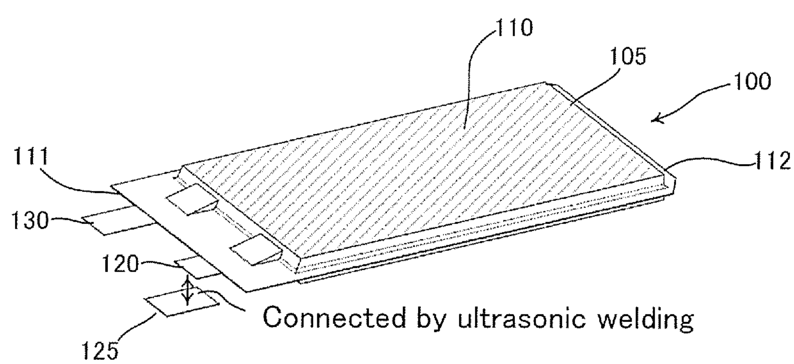

110
105
100
111
112
130
120
Connected by ultrasonic welding
125

FIG.3

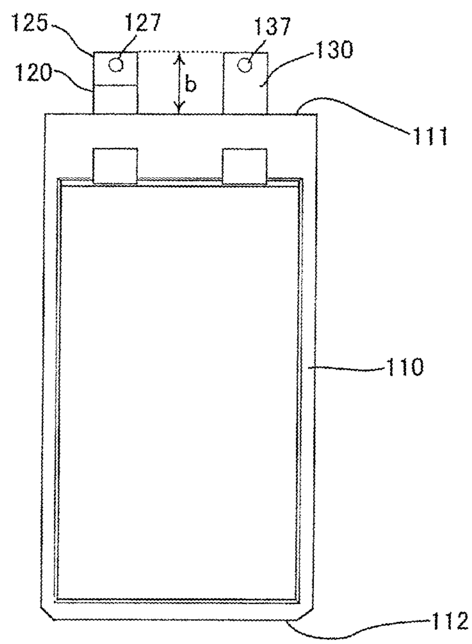


FIG.4

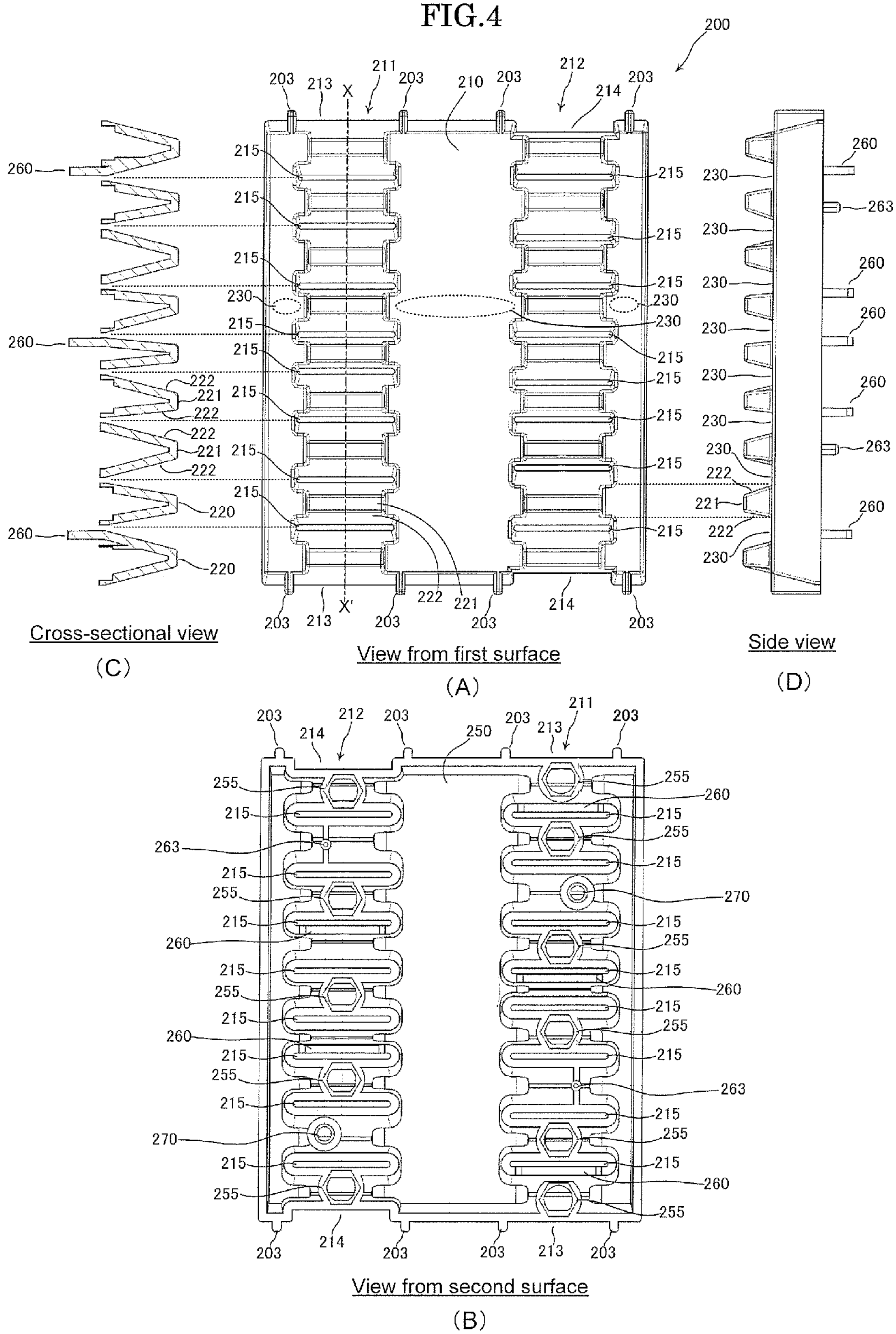
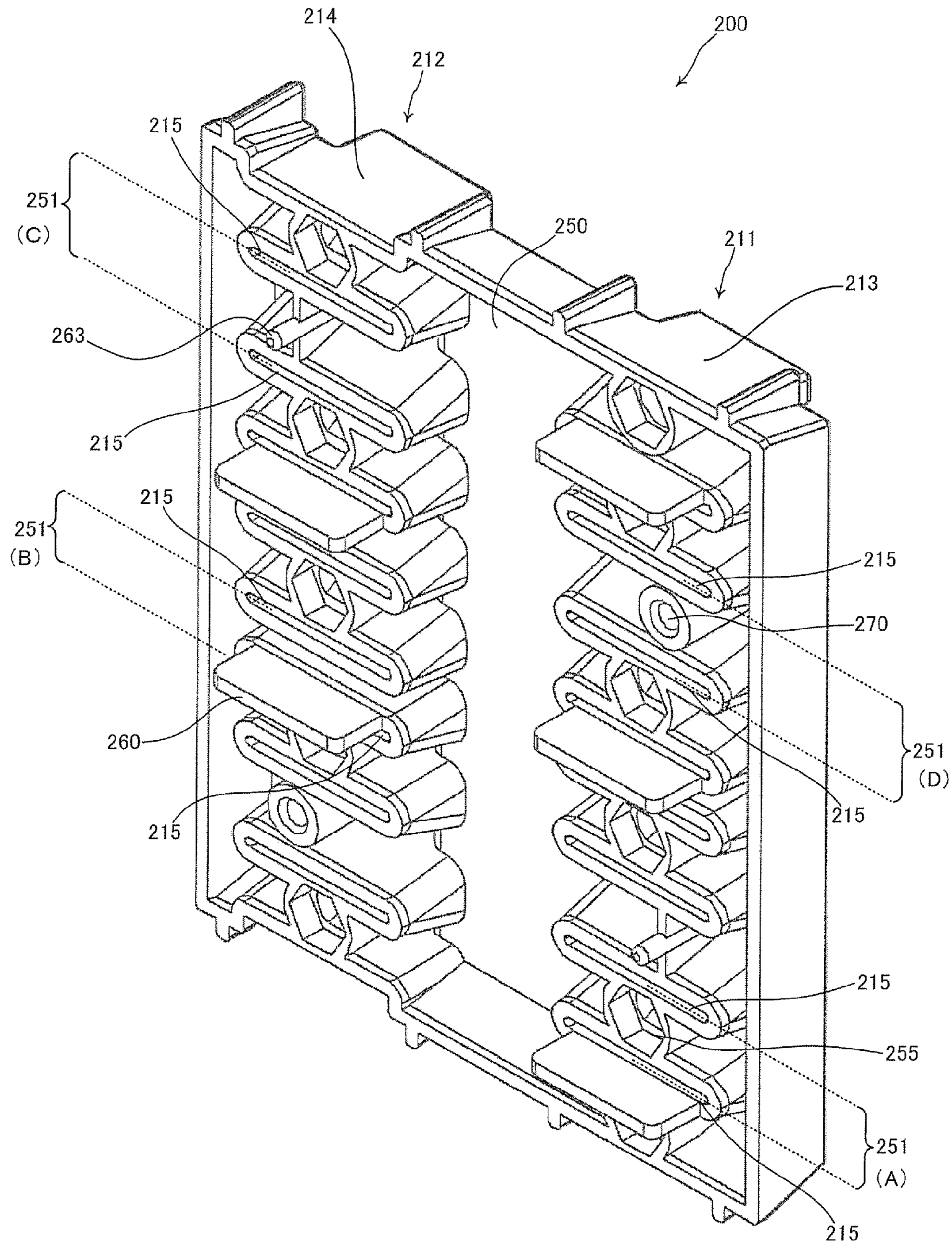

200
203
213
211
X
203
210
212
214
215
230
260
263
222
221
220
X'
Cross-sectional view
(C)
View from first surface
(A)
Side view
(D)
250
255
270
View from second surface
(B)

FIG.5



214
212
200
215
251
(C)
250
211
213
263
215
215
251
(B)
215
270
260
251
(D)
215
215
215
255
251
(A)
215

FIG.6

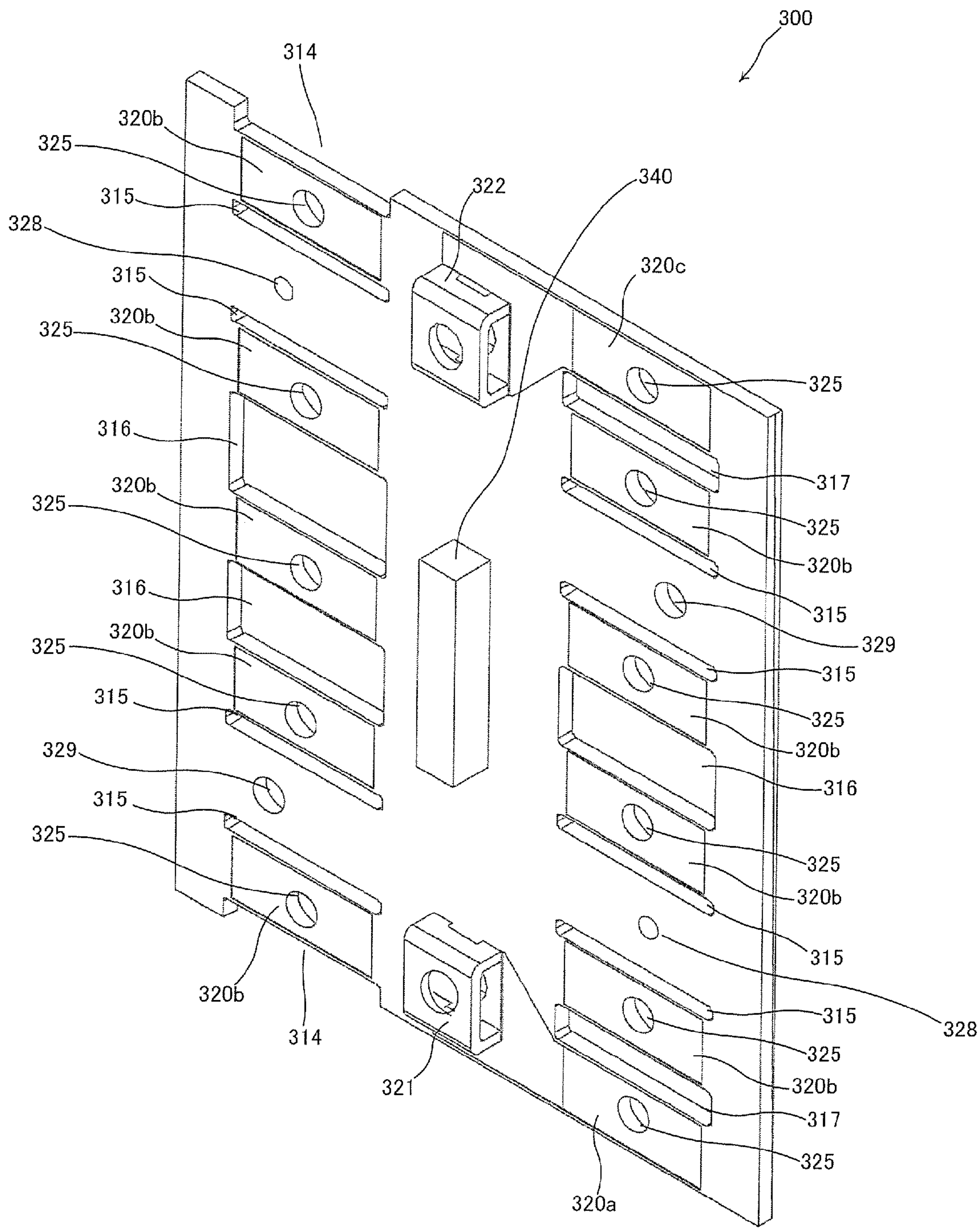
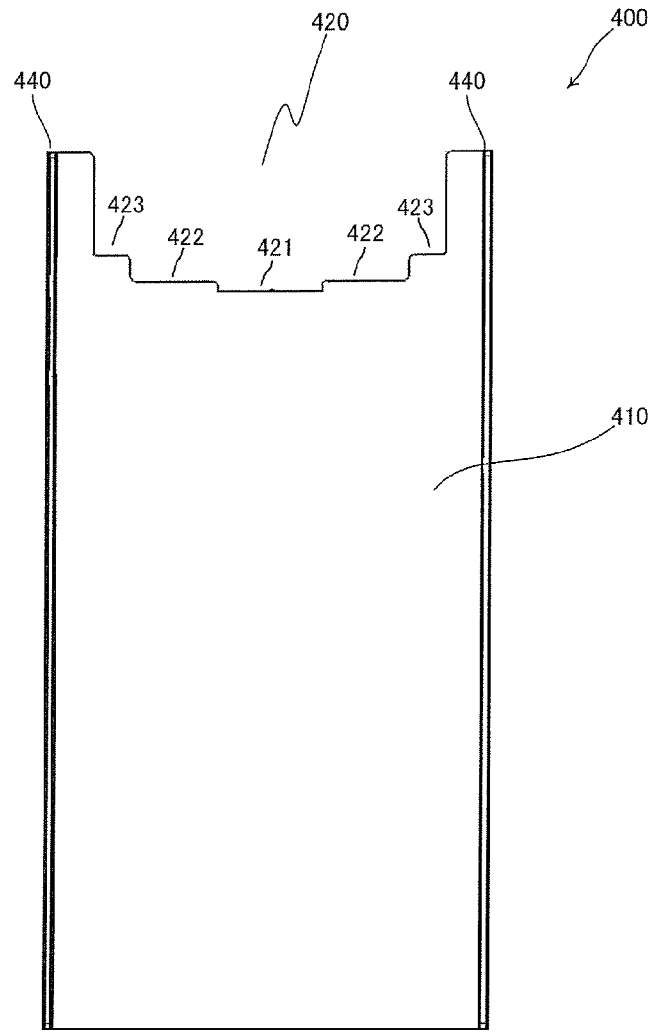
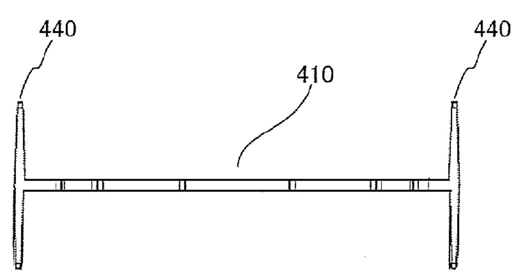

300
314
320b
325
315
328
315
320b
325
316
320b
325
316
320b
325
315
329
315
325
320b
314
322
340
320c
325
317
325
320b
315
329
315
325
320b
316
325
320b
315
328
315
325
320b
317
325
321
320a

FIG.7



(A)



(B)

FIG.8

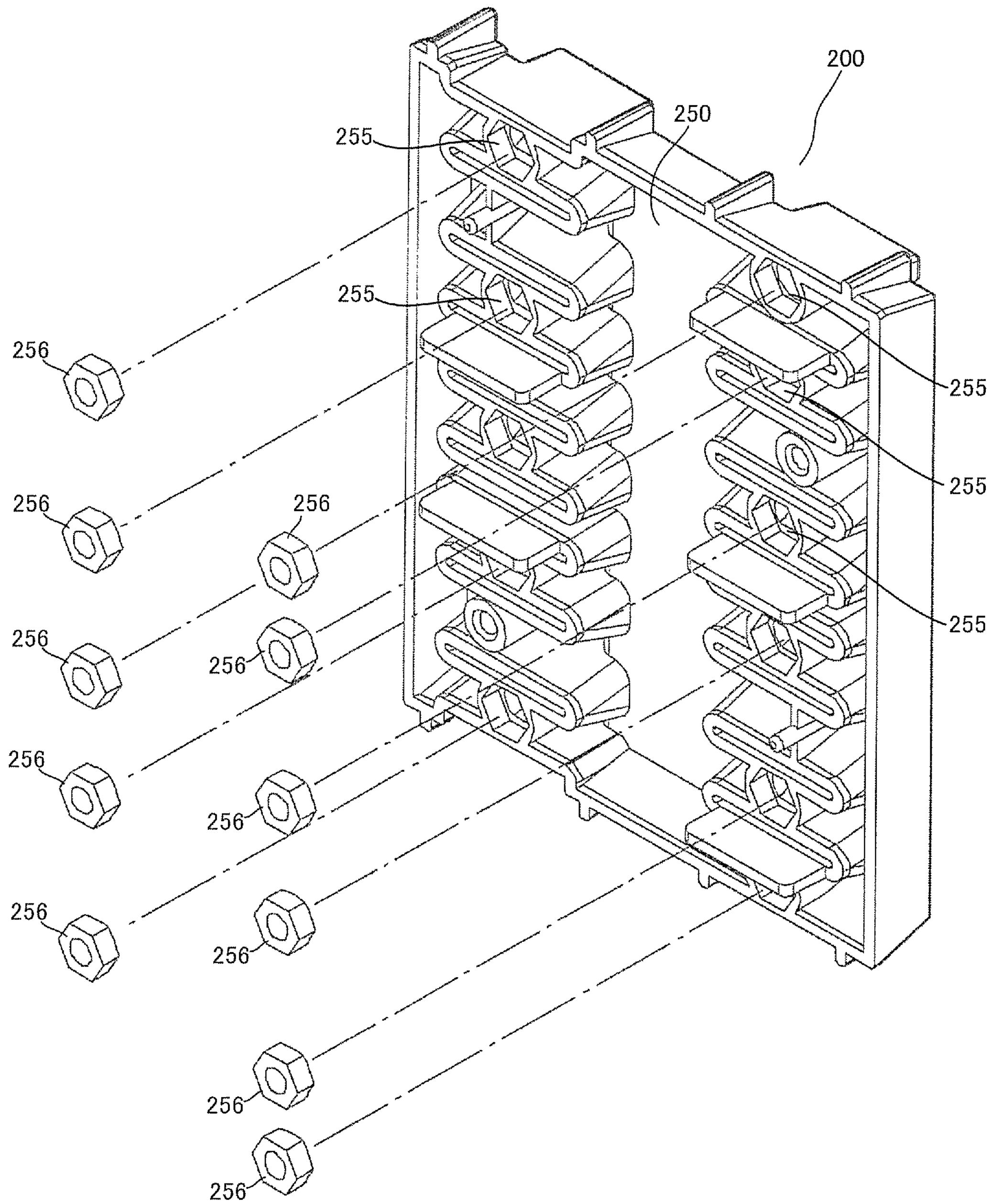

200
250
255
255
255
255
255
256
256
256
256
256
256
256
256
256
256
256
256

FIG.9

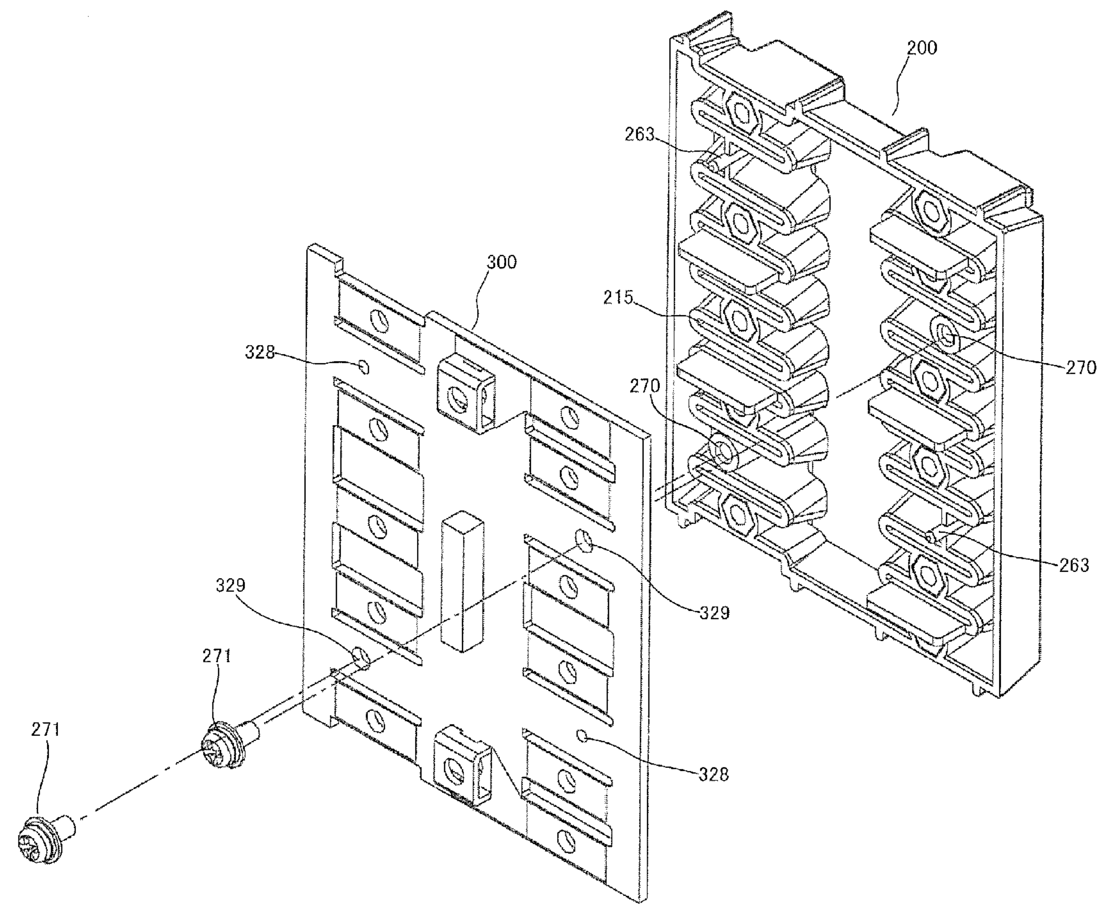


FIG.10

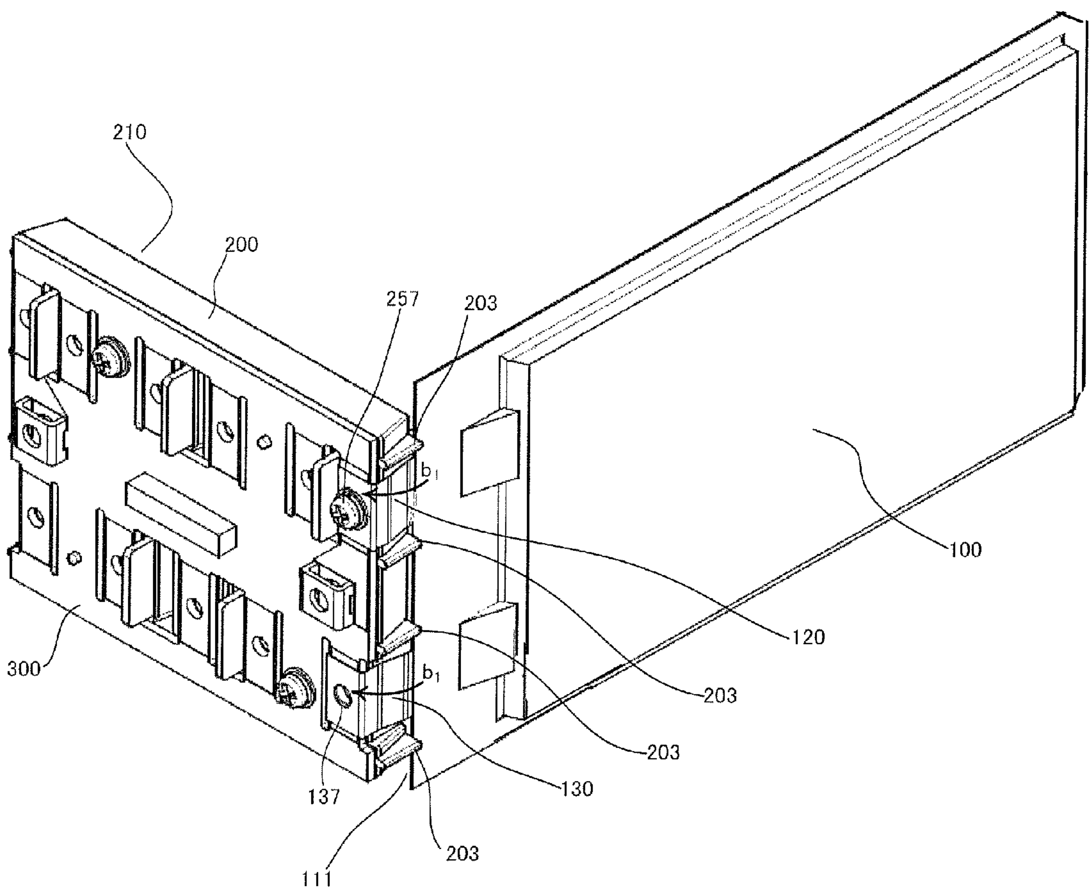


FIG.11

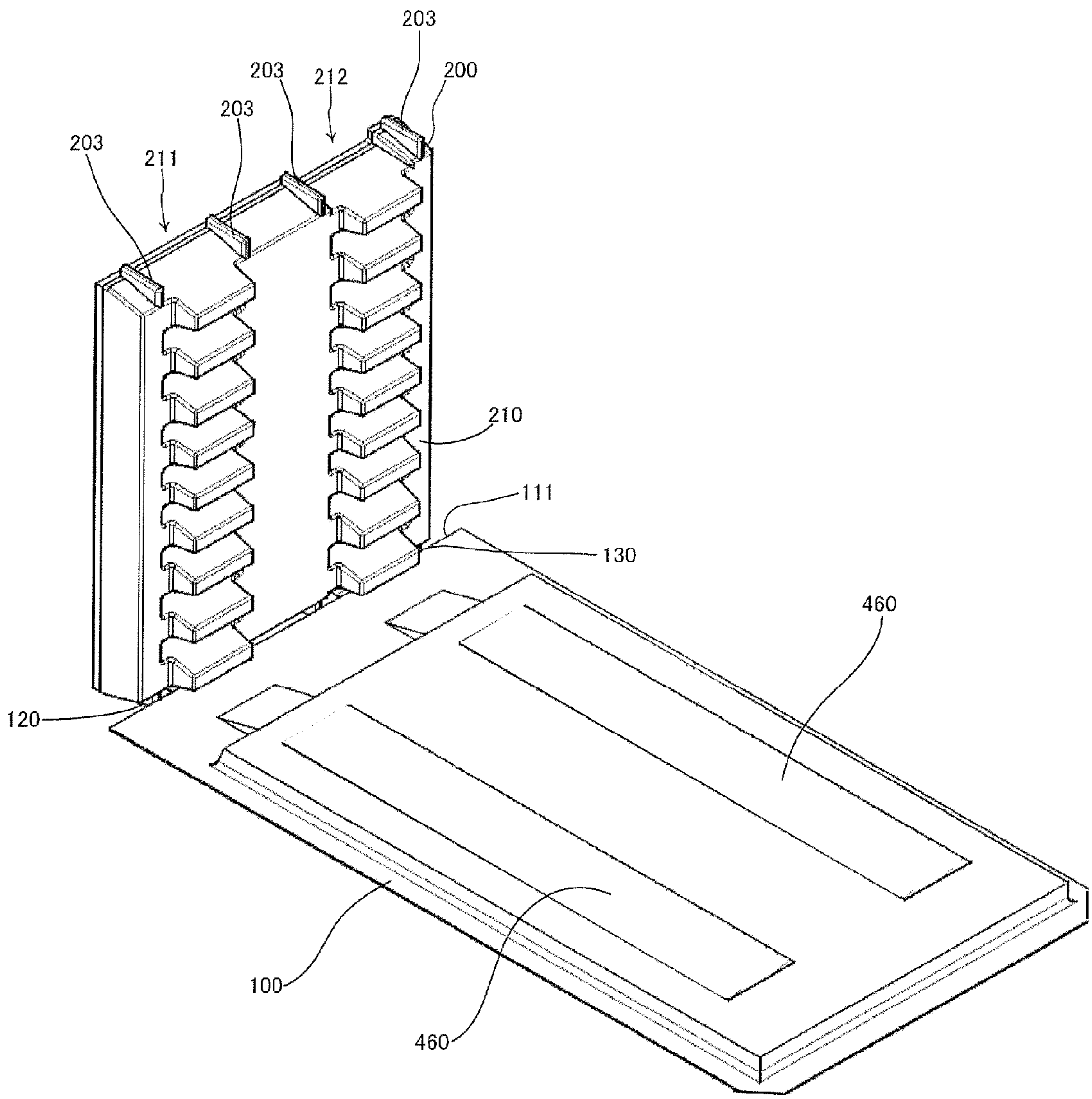


FIG.12

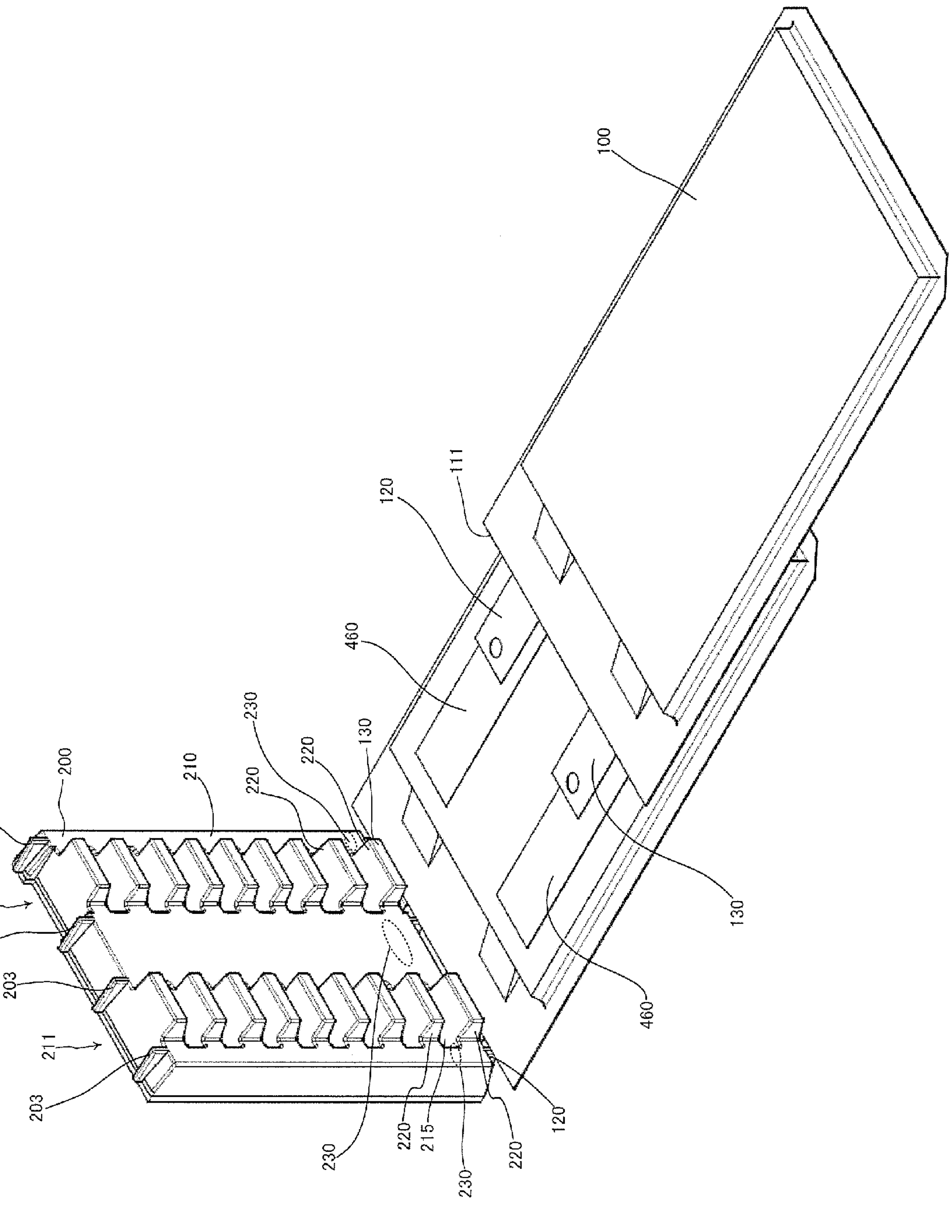

100
111
120
460
230
220
130
210
200
203
212
203
203
211
203
230
220
215
230
220
120
130
460

FIG.13

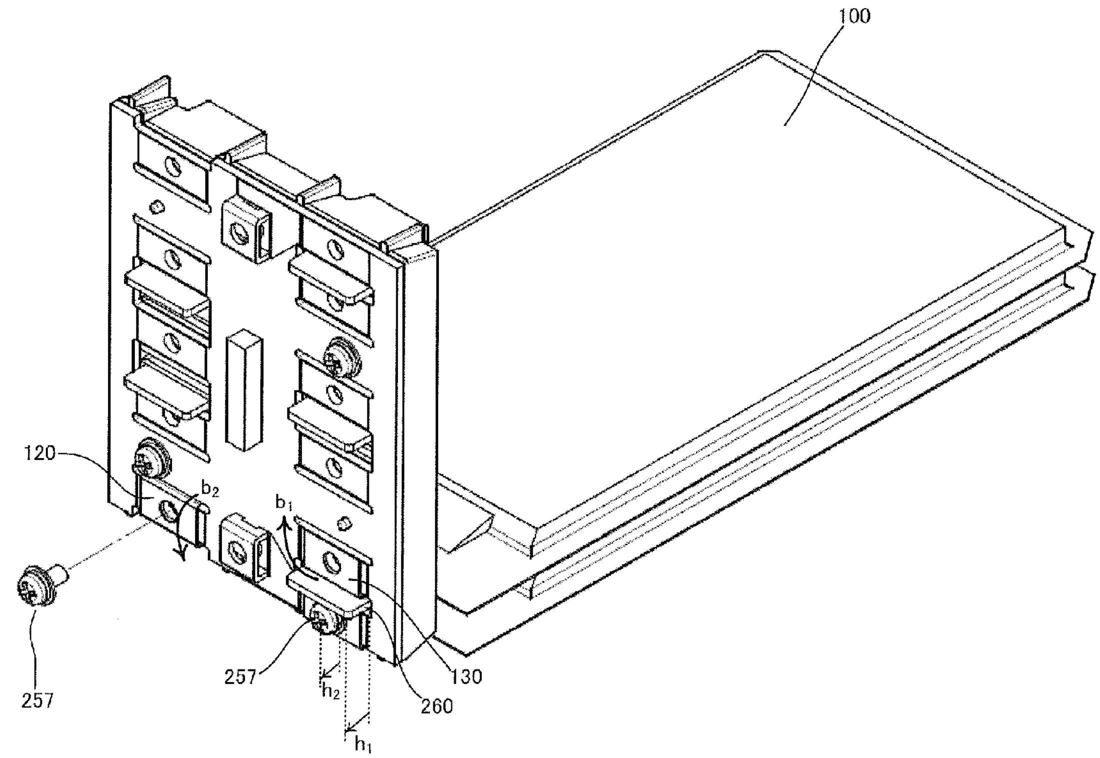


FIG.14

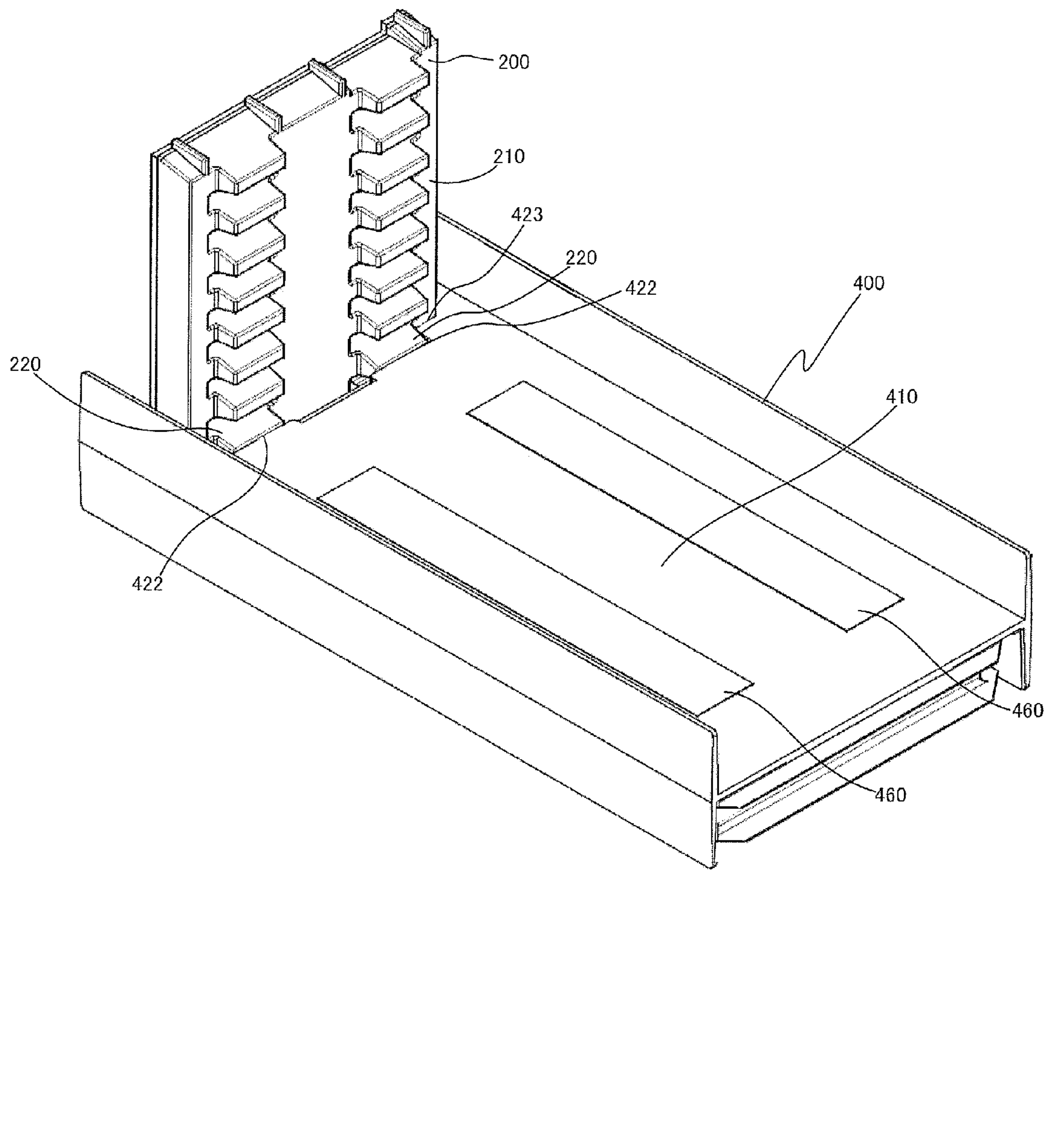


FIG.15

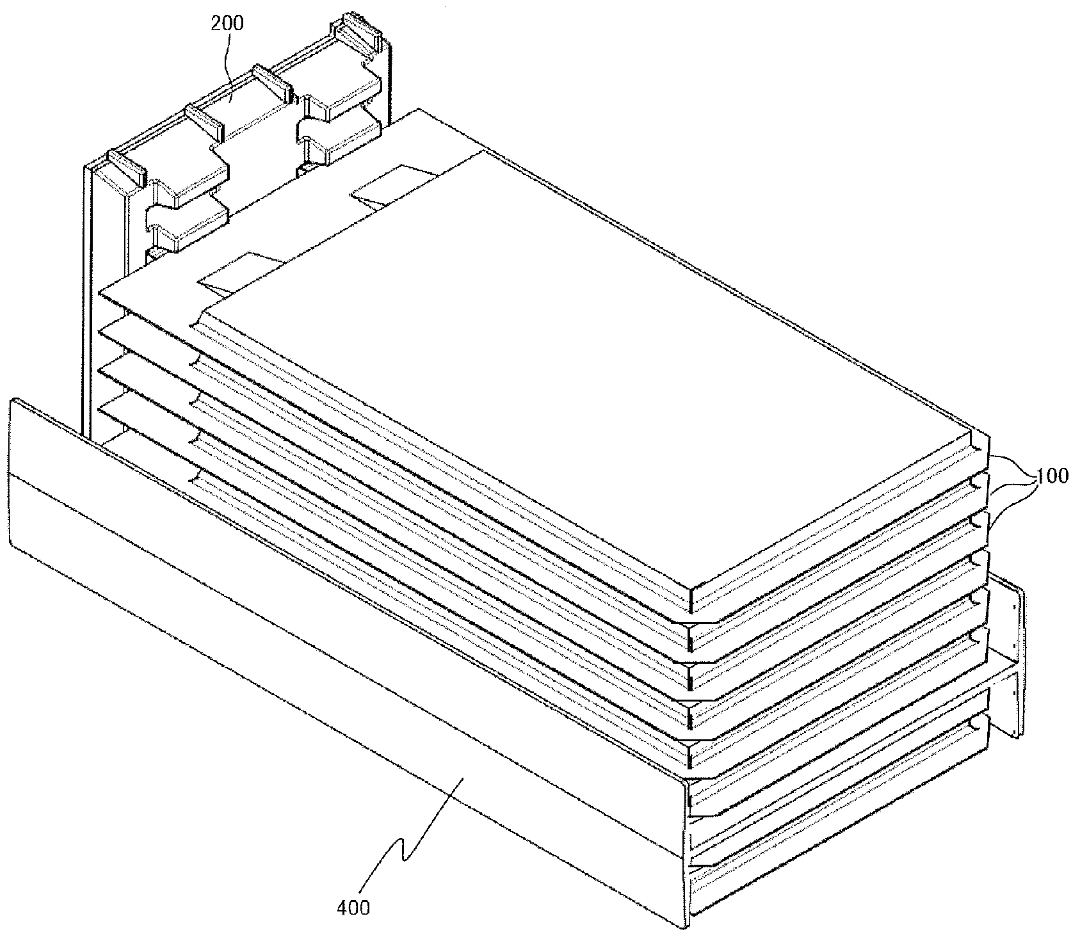


FIG.16

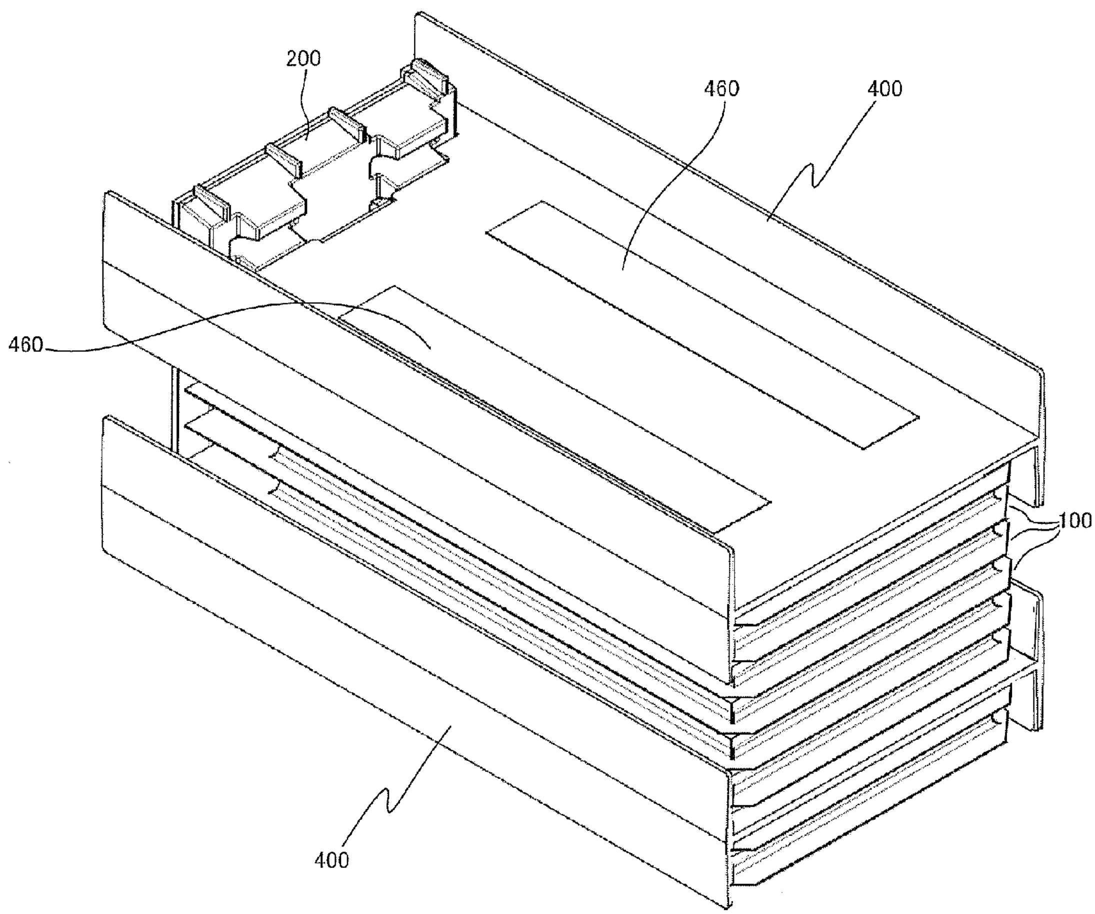


FIG.17

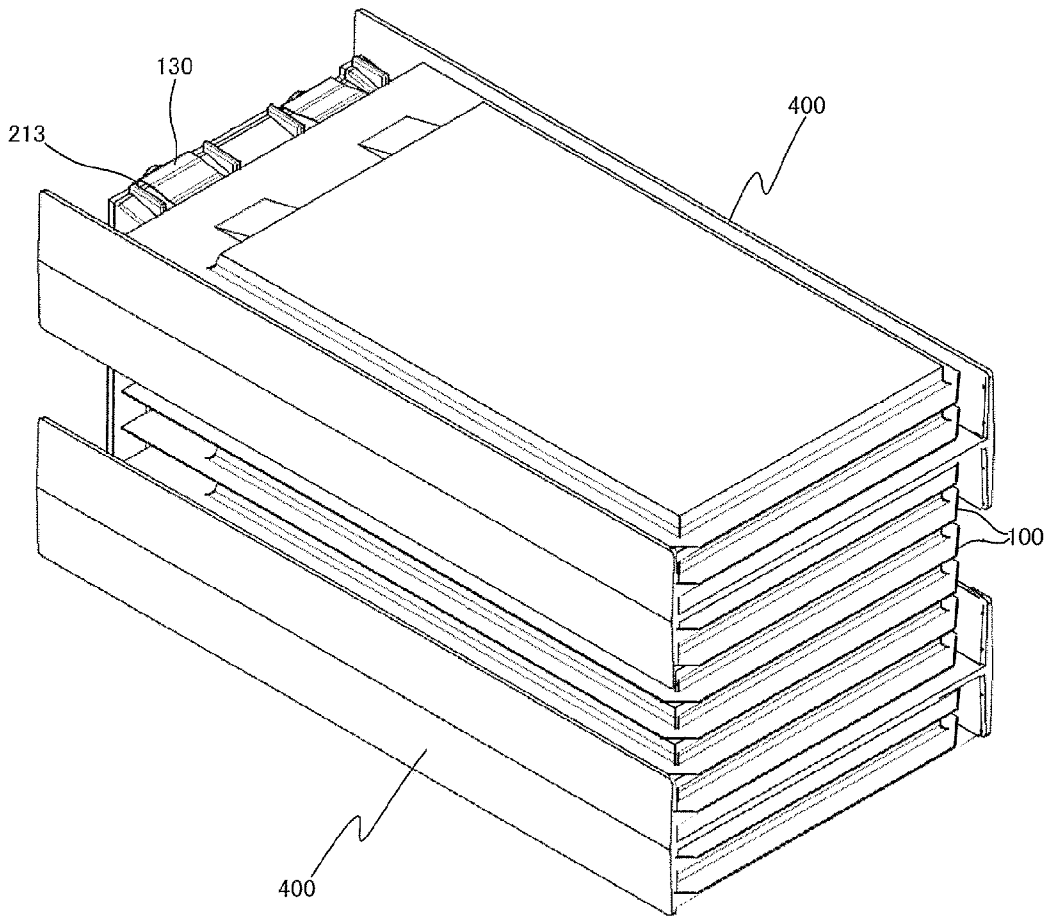


FIG.18

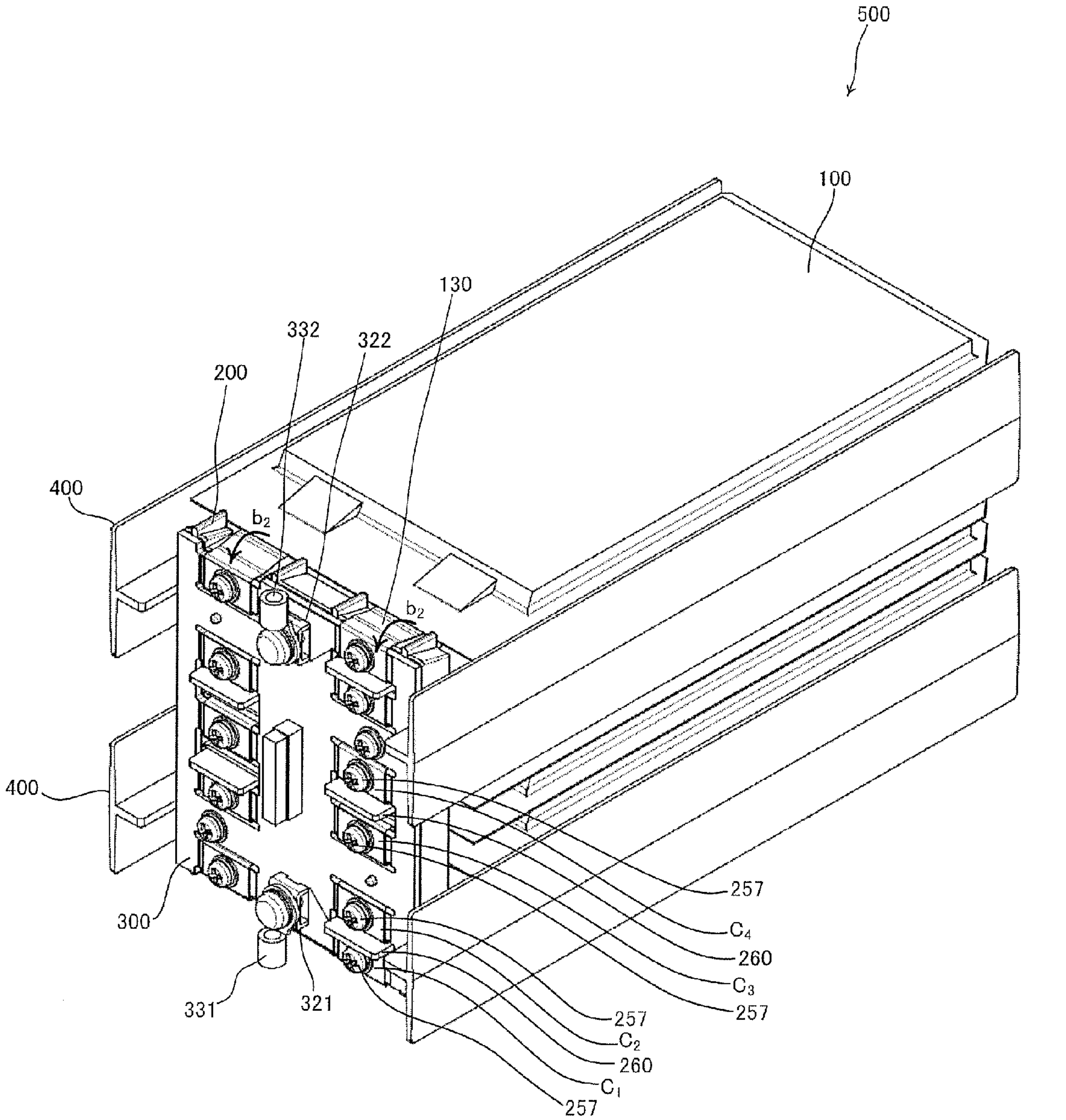

500
100
130
332
322
200
400
b_2
b_2
400
300
331
321
257
C_4
260
C_3
257
257
C_2
260
C_1
257

FIG.19

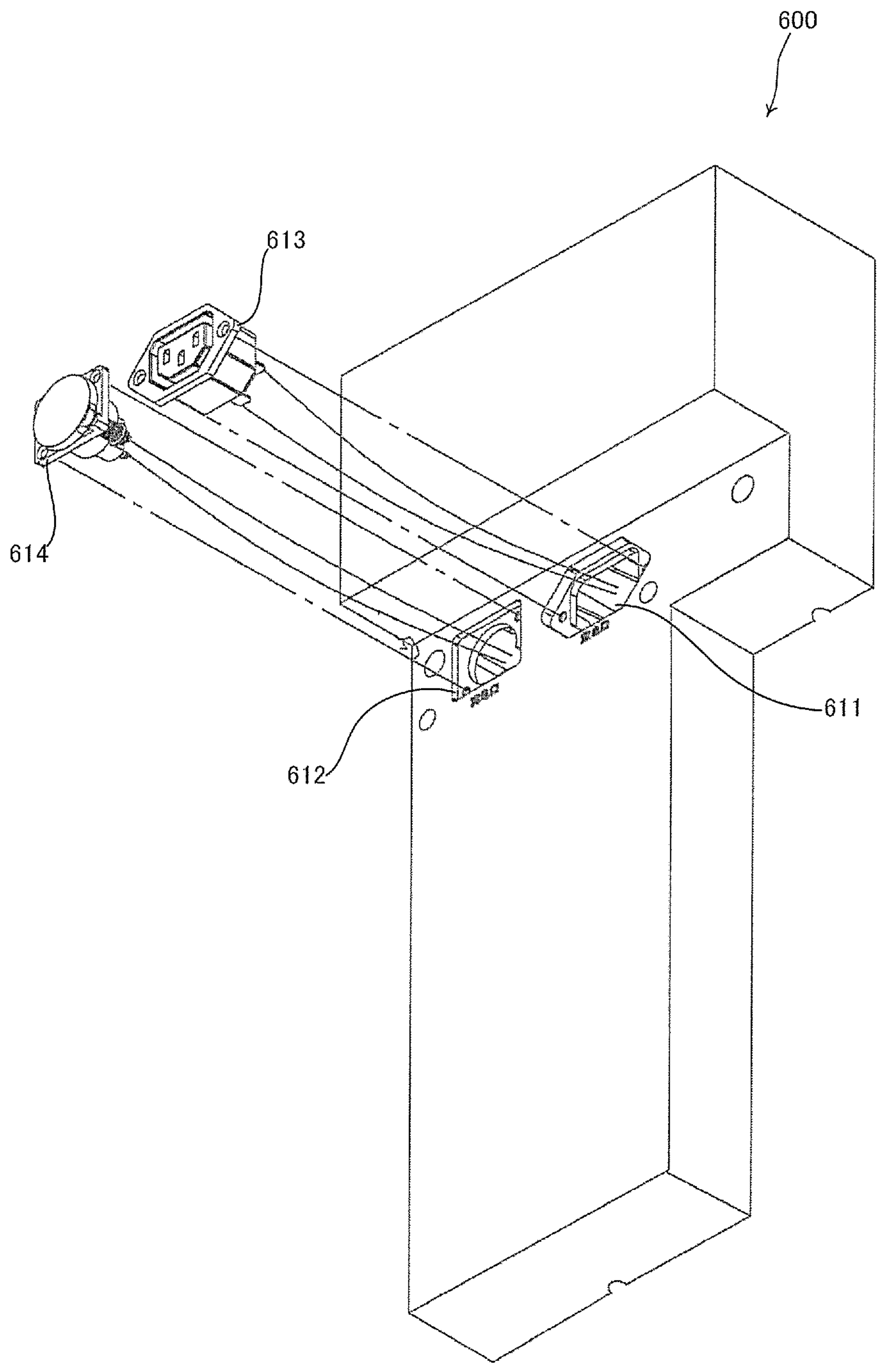


FIG.20

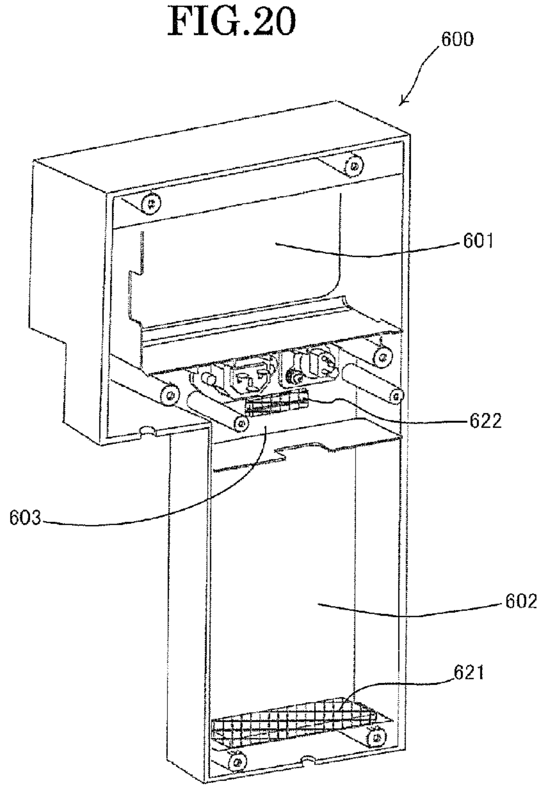


FIG.21

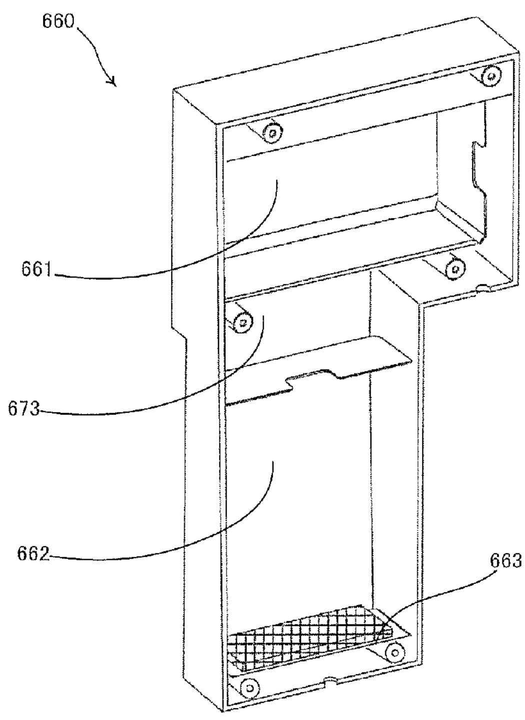


FIG.22

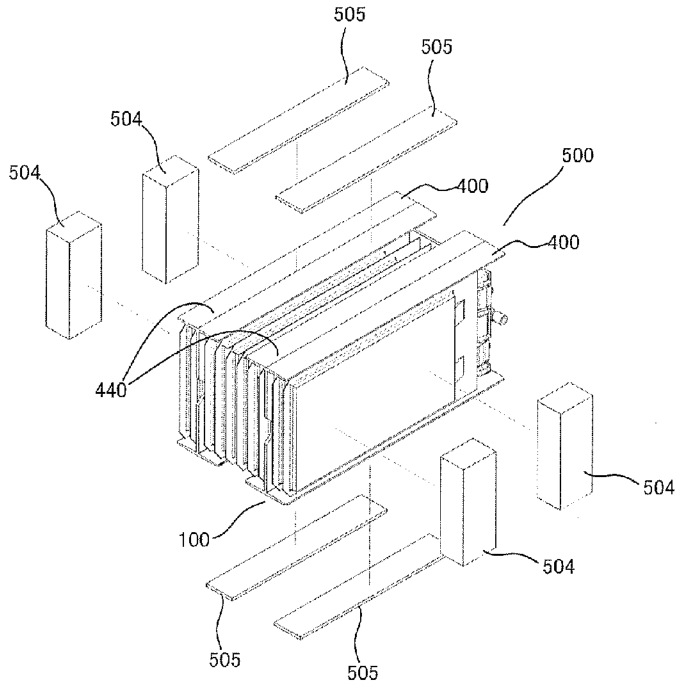

505
505
504
504
500
400
400
440
504
100
504
505
505

FIG.23

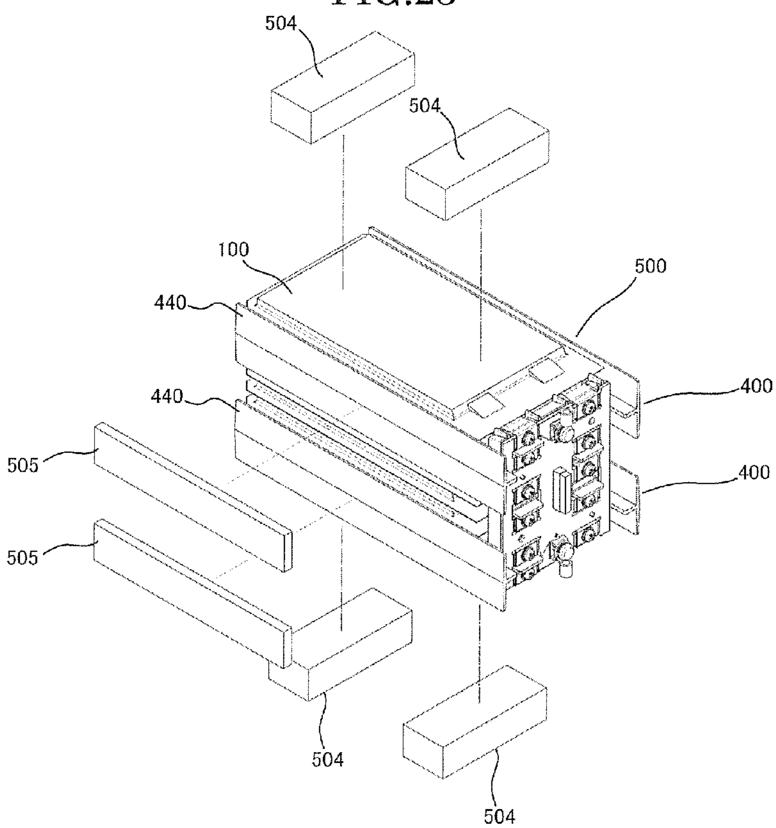

504
504
100
500
440
440
400
505
400
505
504
504

FIG.24

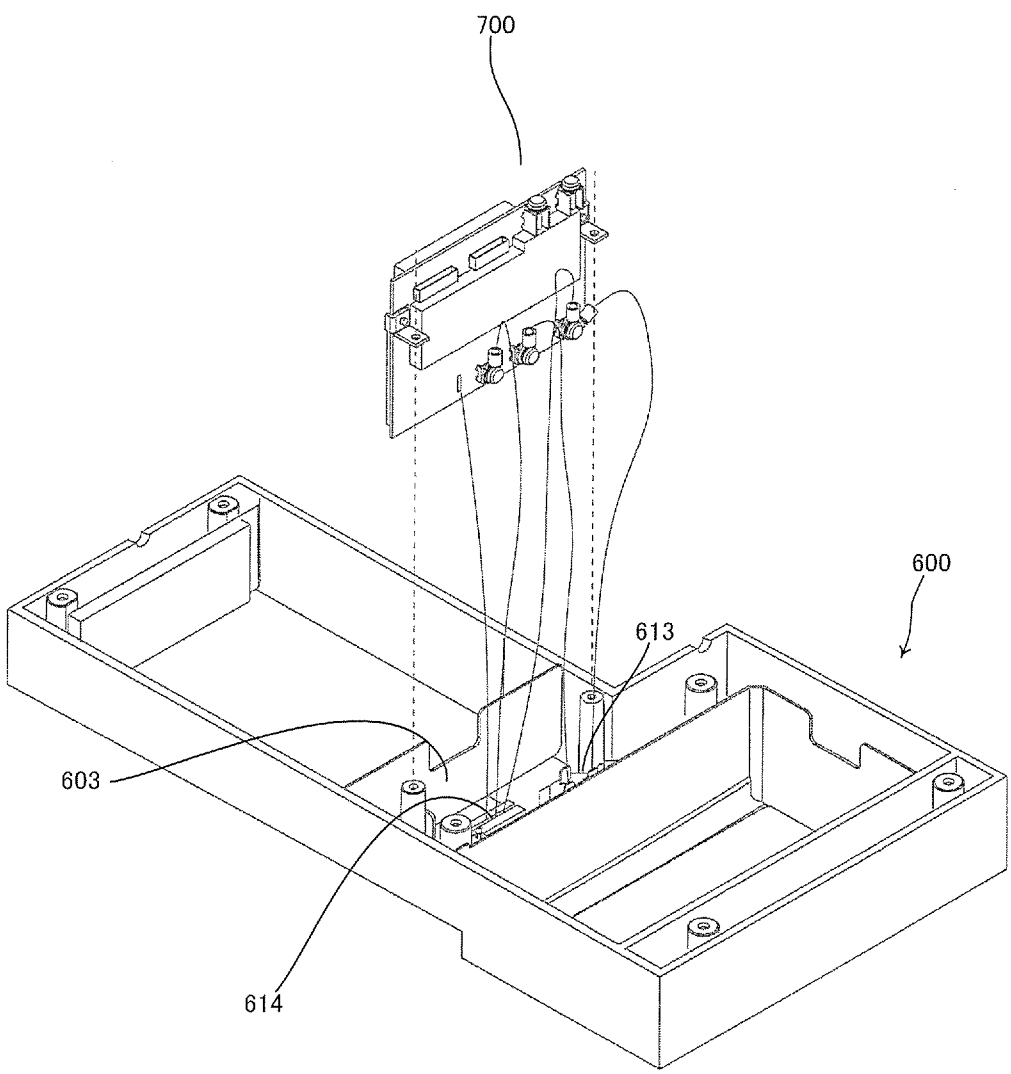


FIG.25

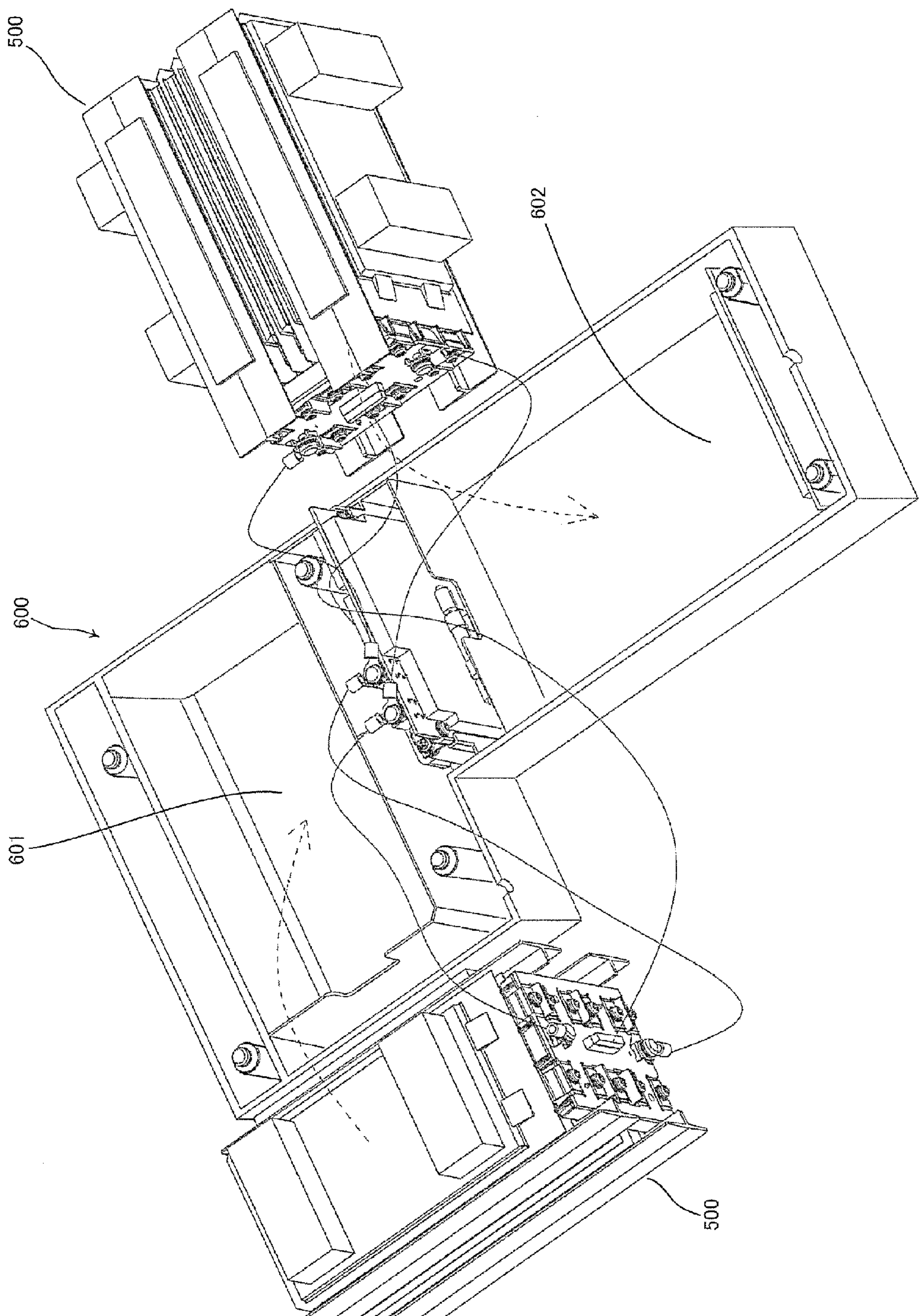


FIG.26

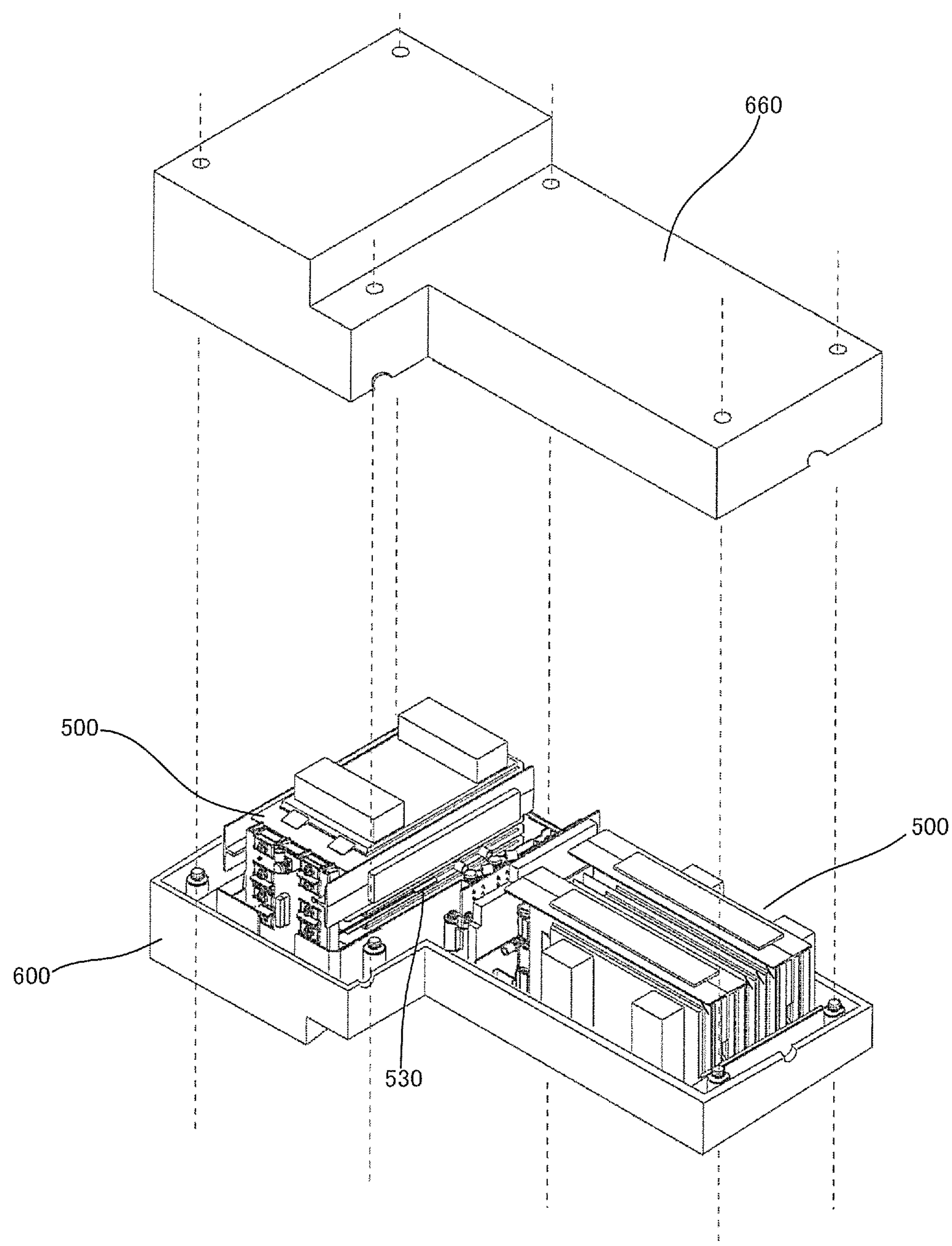


FIG.27

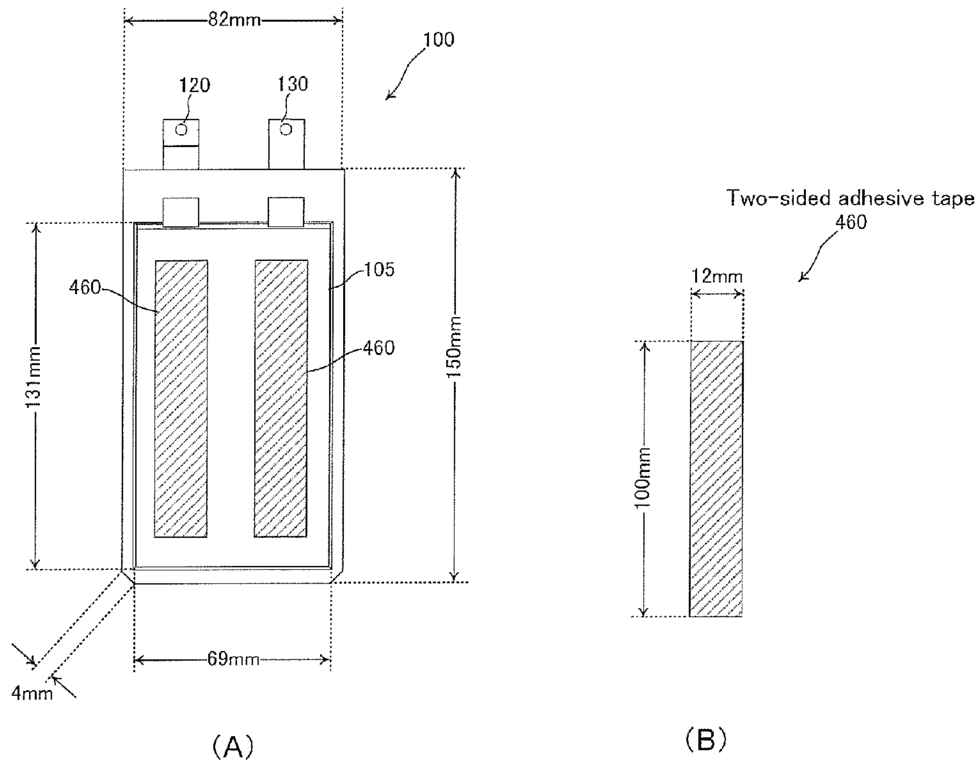

82mm
100
120
130
460
105
460
131mm
150mm
69mm
4mm
(A)
Two-sided adhesive tape
460
12mm
100mm
(B)

FIG.28

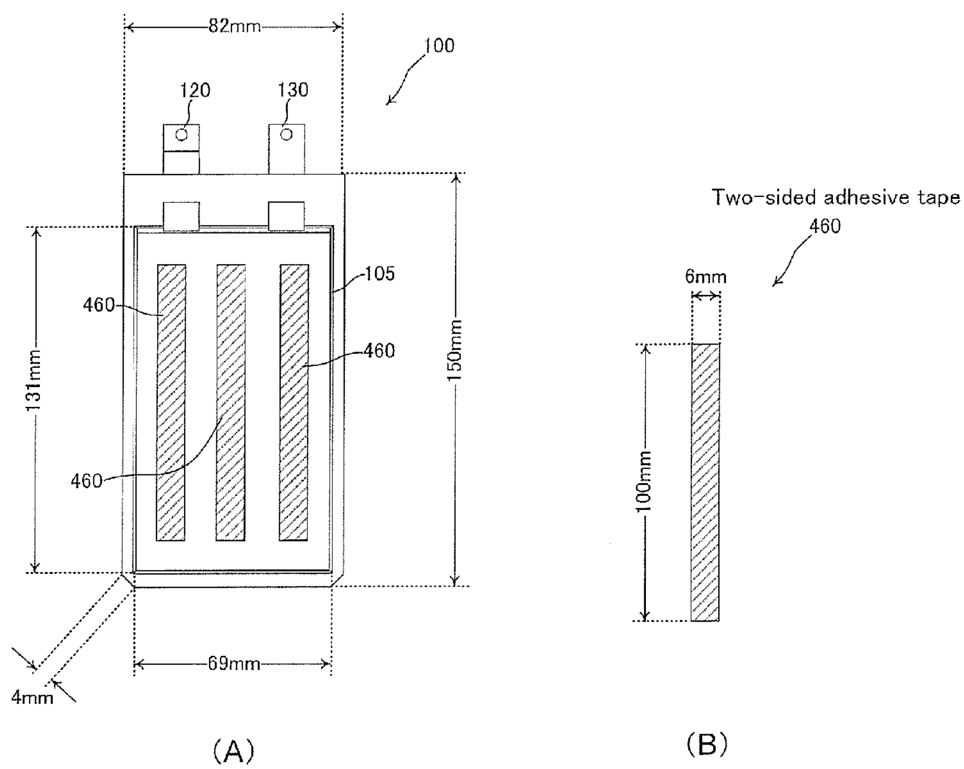
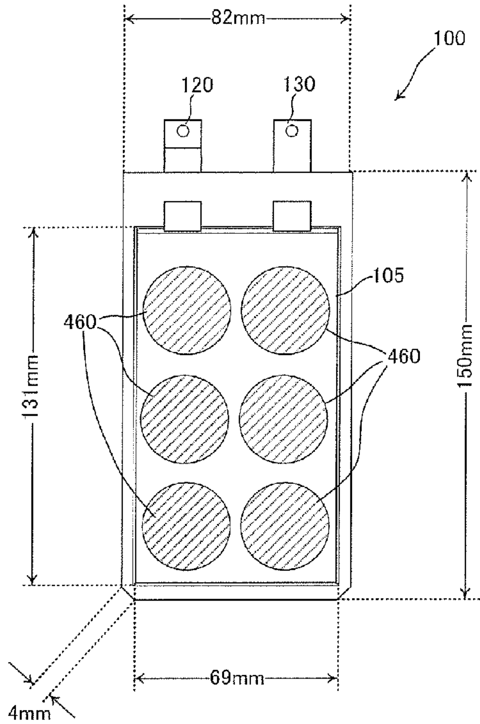
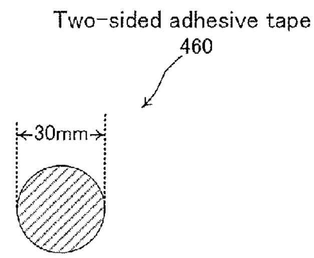

82mm
100
120
130
460
105
460
460
131mm
150mm
69mm
4mm
(A)
Two-sided adhesive tape
460
6mm
100mm
(B)

FIG.29



(A)



(B)

FIG.30

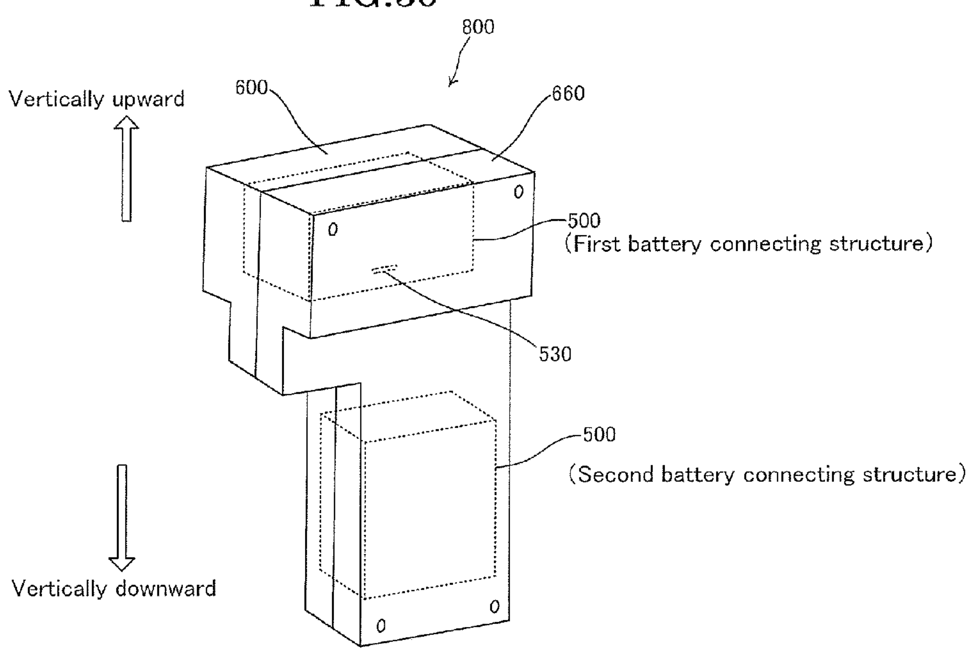
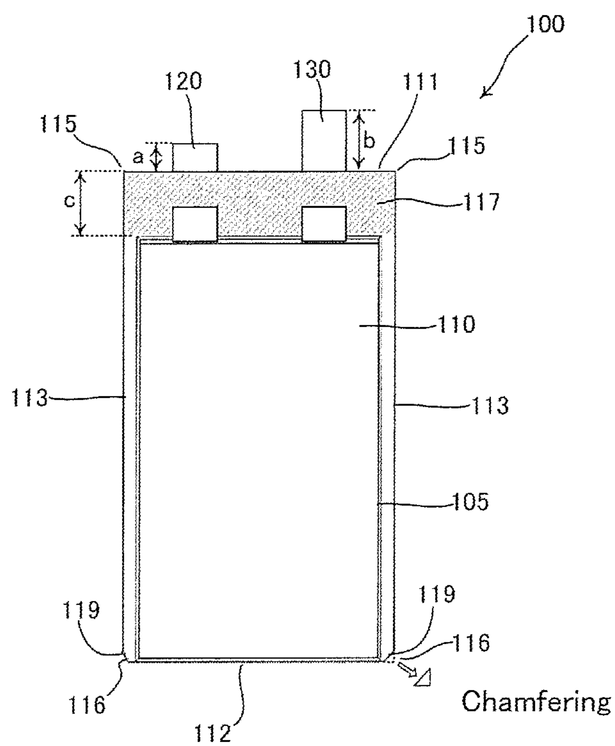


FIG.31


100
120
130
111
115
a
b
115
c
117
110
113
113
105
119
119
116
116
112
Chamfering

BATTERY PACK

This application is the National Phase of PCT/JP2011/005031, filed Sep. 7, 2011, which claims priority to Japanese Application Nos. JP 2011-078335, filed Mar. 31, 2011, JP 2011-078336, filed Mar. 31, 2011, JP 2011-078337, filed Mar. 31, 2011, JP 2011-078338, filed Mar. 31, 2011, JP 2011-078339, filed Mar. 31, 2011, JP 2011-078340, filed Mar. 31, 2011, and JP 2011-078344, filed Mar. 31, 2011, the disclosures of which are hereby incorporated by reference in their entirety.

BACKGROUND OF THE INVENTION

1. Technical Field

The present invention relates to a battery pack that is formed by connecting a plurality of secondary unit batteries, such as lithium ion batteries.

2. Background Art

A lithium ion secondary battery, in which charge and discharge take place as lithium ions move between a negative electrode and a positive electrode, has the following battery characteristics: high energy density and high output power. Therefore, in recent years, the lithium ion secondary battery has been used in various fields. For example, as an energy source for an electric power-assisted bicycle, a battery pack in which a plurality of secondary unit batteries, such as lithium ion batteries, is connected in series may be used.

For the exterior of a secondary unit battery that is used in the above-described manner, a laminate film casing material, which is made of a metallic laminate film, is used in many cases because of the following advantages: the laminate film casing material has a high degree of freedom in shape and is lightweight.

For example, what is disclosed in FIGS. 3 and 4 of Patent Document 1 (JP-A-2010-170799) is an assembled battery 23 in which a plurality of unit batteries 21, which are made from flat non-aqueous electrolyte batteries having a laminate film casing material, is stacked in such a way that negative terminals 6 and positive terminals 7, which extend out of the unit batteries 21, are arranged in the same direction, with an adhesive tape 22 binding the unit batteries 21 together. In the assembled battery 23, a plurality of unit batteries 21 is electrically connected in series to each other.

A battery pack disclosed in Patent Document 1 adopts the following structure: a plurality of unit batteries 21, which are stacked in such a way that the negative terminals 6 and the positive terminals 7 are arranged in the same direction, is electrically connected in series. In order for the unit batteries 21 to be connected in series, the electrodes of different polarities of adjoining unit batteries 21 need to be connected to each other. However, in the battery pack disclosed in Patent Document 1, electric connection sections of the adjoining unit batteries 21 are each disposed obliquely with respect to a direction in which the unit batteries 21 are stacked.

Moreover, as for the flat unit batteries 21 having a laminate film casing material as disclosed in Patent Document 1, the distance between electrodes of the adjoining unit batteries 21 is very short. For the above reason, in a process of producing the battery pack disclosed in Patent Document 1, attention needs to be paid to the following when the electrodes of adjoining unit batteries 21 are connected: a short-circuit between electrodes that are disposed in a small space at a time when the unit batteries 21 are sequentially connected

obliquely with respect to the stacking direction. Therefore, the problem is that work efficiency is poor, and that productivity is low.

SUMMARY OF THE INVENTION

The present invention is intended to solve the above problems. A battery pack of the present invention includes: a plurality of unit batteries that include a positive-electrode pulled-out tab and a negative-electrode pulled-out tab; and a board on which pulled-out tab connection sections are formed to connect the pulled-out tabs of different polarities of adjacent unit batteries.

Moreover, in the battery pack of the present invention, a divider piece is provided between the pulled-out tab connection sections.

Moreover, the battery pack of the present invention includes: a positive electrode washer that is provided on one end portion of the board; a negative electrode washer that is provided on the other end portion that is different from one end portion of the board; a positive-electrode pulled-out tab/positive electrode washer connection section that connects the positive-electrode pulled-out tab of the unit battery, which is disposed on one end portion of the board, to the positive electrode washer; and a negative-electrode pulled-out tab/negative electrode washer connection section that connects the negative-electrode pulled-out tab of the unit battery, which is disposed on the other end portion of the board, to the negative electrode washer.

Moreover, in the battery pack of the present invention, the positive-electrode and negative-electrode pulled-out tabs of the unit battery, which is disposed on one end portion of the board, are both bent in the same direction.

Moreover, in the battery pack of the present invention, the positive-electrode and negative-electrode pulled-out tabs of the unit battery, which is disposed on the other end portion of the board, are both bent in the same direction.

Moreover, in the battery pack of the present invention, the positive-electrode and negative-electrode pulled-out tabs of the unit battery, whose pulled-out tabs are connected by the pulled-out tab connection section, are bent in opposite directions.

Moreover, in the battery pack of the present invention, the height of the divider piece from the board is higher than the height of a bolt used to connect pulled-out tabs in the pulled-out tab connection section.

Moreover, the battery pack of the present invention includes a holder member that is fixed to the board and includes holes into which the positive-electrode and negative-electrode pulled-out tabs of a plurality of the unit batteries are inserted.

Moreover, in the battery pack of the present invention, guide projecting sections are provided on the holder member in such a way that the holes are sandwiched therebetween.

Moreover, in the battery pack of the present invention, tapered sides are provided on the guide projecting sections.

Moreover, in the battery pack of the present invention, the pulled-out tabs of different polarities of adjacent unit batteries are connected in the pulled-out tab connection section with connection members, a plurality of the holes are provided on the holder member, and bridging structure sections are provided between a plurality of the holes.

Moreover, in the battery pack of the present invention, the connection members are bolts and nuts.

Moreover, in the battery pack of the present invention, nut housing sections are provided in the bridging structure sections to house the nuts.

Moreover, in the battery pack of the present invention, a divider piece, which is disposed between the pulled-out tab connection sections, is provided in the bridging structure section.

Moreover, in the battery pack of the present invention, a positioning projecting section is provided in the bridging structure section and used to position the board and the holder member.

Moreover, in the battery pack of the present invention, a screw hole, into which a fixing screw for fixing the board to the holder member is screwed, is provided in the bridging structure section.

According to the battery pack of the present invention, the pulled-out tabs of different polarities of a plurality of unit batteries are connected on the board. Therefore, the production of battery packs is highly efficient, resulting in an improvement in productivity.

Moreover, according to the battery pack of the present invention, the positive-electrode and negative-electrode pulled-out tabs of a plurality of unit batteries are inserted into the holes of the holder member, and the pulled-out tabs of different polarities of a plurality of the unit batteries are connected on the board. Therefore, the production of battery packs is highly efficient, resulting in an improvement in productivity.

Moreover, according to the battery pack of the present invention, the positive-electrode and negative-electrode pulled-out tabs of a plurality of unit batteries are inserted into the holes of the holder member, and the pulled-out tabs of different polarities of a plurality of the unit batteries are connected on the board with bolts and nuts. Therefore, it is easy to connect a plurality of the unit batteries electrically. Thus, the production of battery packs is highly efficient, resulting in an improvement in productivity.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a diagram showing a unit battery **100**, which makes up a battery pack according to an embodiment of the present invention;

FIG. **2** is a diagram showing how an adding tab member **125** is connected to a positive-electrode pulled-out tab **120** of the unit battery **100**;

FIG. **3** is a diagram showing how holes are provided on a positive-electrode pulled-out tab and a negative-electrode pulled-out tab before unit batteries **100** are connected in series;

FIGS. **4**A to **4**D are diagrams illustrating a holder member **200**, which is used to form the battery pack according to the embodiment of the present invention;

FIG. **5** is a perspective view of the holder member **200**, which is used to form the battery pack according to the embodiment of the present invention;

FIG. **6** is a perspective view of a board **300**, which is used to connect unit batteries **100** in series in the battery pack according to an embodiment of the present invention;

FIGS. **7**A and **7**B are diagrams illustrating a battery protective member **400**, which is used to form the battery pack according to the embodiment of the present invention;

FIG. **8** is a diagram illustrating a process of producing a battery connecting structure **500**, which makes up the battery pack according to the embodiment of the present invention;

FIG. **9** is a diagram illustrating a process of producing the battery connecting structure **500**, which makes up the battery pack according to the embodiment of the present invention;

FIG. **10** is a diagram illustrating a process of producing the battery connecting structure **500**, which makes up the battery pack according to the embodiment of the present invention;

FIG. **11** is a diagram illustrating a process of producing the battery connecting structure **500**, which makes up the battery pack according to the embodiment of the present invention;

FIG. **12** is a diagram illustrating a process of producing the battery connecting structure **500**, which makes up the battery pack according to the embodiment of the present invention;

FIG. **13** is a diagram illustrating a process of producing the battery connecting structure **500**, which makes up the battery pack according to the embodiment of the present invention;

FIG. **14** is a diagram illustrating a process of producing the battery connecting structure **500**, which makes up the battery pack according to the embodiment of the present invention;

FIG. **15** is a diagram illustrating a process of producing the battery connecting structure **500**, which makes up the battery pack according to the embodiment of the present invention;

FIG. **16** is a diagram illustrating a process of producing the battery connecting structure **500**, which makes up the battery pack according to the embodiment of the present invention;

FIG. **17** is a diagram illustrating a process of producing the battery connecting structure **500**, which makes up the battery pack according to the embodiment of the present invention;

FIG. **18** is a diagram illustrating a process of producing the battery connecting structure **500**, which makes up the battery pack according to the embodiment of the present invention;

FIG. **19** is a diagram illustrating a process of producing the battery pack according to the embodiment of the present invention;

FIG. **20** is a diagram illustrating a process of producing the battery pack according to the embodiment of the present invention;

FIG. **21** is a diagram illustrating a process of producing the battery pack according to the embodiment of the present invention;

FIG. **22** is a diagram illustrating a process of producing the battery pack according to the embodiment of the present invention;

FIG. **23** is a diagram illustrating a process of producing the battery pack according to the embodiment of the present invention;

FIG. **24** is a diagram illustrating a process of producing the battery pack according to the embodiment of the present invention;

FIG. **25** is a diagram illustrating a process of producing the battery pack according to the embodiment of the present invention;

FIG. **26** is a diagram illustrating a process of producing the battery pack according to the embodiment of the present invention;

FIGS. **27**A and **27**B are diagrams illustrating conditions for bonding unit batteries **100** together;

FIGS. **28**A and **28**B are diagrams illustrating another example of conditions for bonding unit batteries **100** together;

FIGS. **29**A and **29**B are diagrams illustrating another example of conditions for bonding unit batteries **100** together;

FIG. **30** is a diagram showing how the battery pack is positioned when in use according to the embodiment of the present invention; and

FIG. **31** is a diagram showing another example of a unit battery **100**, which makes up a battery pack.

DESCRIPTION OF EXEMPLARY EMBODIMENTS

The following describes an embodiment of the present invention with reference to the accompanying drawings. FIG.

1 is a diagram showing a unit battery **100** that makes up a battery pack according to an embodiment of the present invention. What is used for the unit battery **100** is a lithium ion secondary unit battery in which charge and discharge take place as lithium ions move between negative and positive electrodes.

A battery main unit **110** of the unit battery **100** has a structure in which the following components are stored in a laminate film casing material, which is in the shape of a rectangle in planar view: an electrode laminated body, in which a plurality of sheet positive electrodes and a plurality of sheet negative electrodes are stacked via separators, and an electrolytic solution (both not shown). From a first end portion **111** of the battery main unit **110**, a positive-electrode pulled-out tab **120** and a negative-electrode pulled-out tab **130** are pulled out.

The positive-electrode pulled-out tab **120** and the negative-electrode pulled-out tab **130** are both in the shape of a flat plate, and are each connected directly, or via a lead body or the like, to the sheet positive electrodes and the sheet negative electrodes in the laminate film casing material. The laminate film casing material includes a metallic laminate film having a heat-sealing resin layer on a plane facing the inside of the battery. More specifically, for example, the laminate film casing material is made by stacking two metallic laminate films; after an electrode laminated body, which includes the sheet positive electrodes, sheet negative electrodes and separators, and an electrolytic solution are stored in the laminate film casing material, the periphery of the laminate film casing material (the first end portion **111**, a second end portion **112** and two side end portions **113**) is heat-sealed. Therefore, the inside thereof is hermetically sealed.

In this case, a metallic piece that is pulled out of the battery main unit **110**, which includes laminate film casing materials such as the positive-electrode pulled-out tab **120** and the negative-electrode pulled-out tab **130**, is referred to as a "pulled-out tab." The sheet positive electrodes and sheet negative electrodes that are stacked via separators or electrolytic solution inside the laminate film casing material are referred to as "electrodes."

Incidentally, the electrode laminated bodies include not only the one in which a plurality of sheet positive electrodes and a plurality of sheet negative electrodes are stacked via separators as described above but also a laminated body in which the sheet positive electrodes and the sheet negative electrodes are stacked via separators, wound around and compressed.

In the above unit battery **100**, aluminum or aluminum alloy is used as a material of the positive-electrode pulled-out tab **120**. As a material of the negative-electrode pulled-out tab **130**, the following are generally used: nickel; a material made by plating another metal with nickel (which is a nickel-plated material, for example, nickel-plated copper); a clad made of nickel and another metal (a nickel-clad material, for example, nickel-copper clad). That is, the unit battery **100** is so formed as to include the positive-electrode pulled-out tab **120** containing aluminum and the negative-electrode pulled-out tab **130** containing nickel. According to the present embodiment, the positive-electrode pulled-out tab **120** made of aluminum and the negative-electrode pulled-out tab **130** made of nickel are used.

In order to make a battery pack of the present invention, a positive-electrode pulled-out tab **120** of a unit battery **100** and a negative-electrode pulled-out tab **130** of a unit battery **100**, which is adjacent to the above unit battery **100**, are mechanically bound together with bolts and nuts and therefore connected together electrically.

In this case, the structure in which the positive-electrode pulled-out tab **120**, which contains aluminum, of the unit battery **100** and the negative-electrode pulled-out tab **130**, which contains nickel, are mechanically bound together could lead to a decline in conductivity after a predetermined period of time has passed due to problems pertaining to differences in potential.

Accordingly, in the battery pack of the present invention, an adding tab **125** containing nickel is welded to the positive-electrode pulled-out tab **120** of the unit battery **100**. When a plurality of unit batteries **100** is connected in series, the adding tab **125** of one unit battery **100** described above is connected to the negative-electrode pulled-out tab **130** of the other unit battery **100**, thereby solving the problem of a decline in conductivity that arises from problems pertaining to differences in potential.

The configuration to achieve the above will be described. As shown in FIG. **1**, in a process of making the battery pack, suppose that the aluminum positive-electrode pulled-out tab **120** of the unit battery **100** has a length of a from the first end portion **111**, and the nickel negative-electrode pulled-out tab **130** a length of b (b>a) from the first end portion **111**. Then, to the aluminum positive-electrode pulled-out tab **120** having a length of a, an adding tab member **125** made of nickel is connected and added by ultrasonic welding so that the length from the first end portion **111** comes to b (see FIGS. **2** and **3**). In order to allow unit batteries **100** to be connected in series, a hole **127** is made on the adding tab member **125**, which serves as a positive-electrode pulled-out tab; a hole **137** is made on the negative-electrode pulled-out tab **130**. Incidentally, hereinafter, the entire pulled-out tab, which is formed by connecting the adding tab member **125**, may also be referred to as a positive-electrode pulled-out tab **120**.

As described below, in the battery pack of the present invention, in a process of electrically connecting a plurality of unit batteries **100**, the pulled-out tabs are mechanically connected together in such a way that the members containing nickel (the adding tab members **125** and the negative-electrode pulled-out tabs **130**) come in contact with each other. Accordingly, the electrically connected portions of the adjoining unit batteries turn out to be the portions that are made of the same type of metallic material and are connected electrically. Therefore, the problems pertaining to differences in potential do not arise, and it is substantially possible to prevent a decline over time in conductivity from occurring.

The following describes a holder member **200**, which is used in electrically connecting the positive-electrode pulled-out tabs and negative-electrode pulled-out tabs of a plurality of unit batteries **100** in the battery pack of the embodiment of the present invention. FIGS. **4**A to **4**D are diagrams illustrating the holder member **200**. FIG. **4**A is a diagram showing the holder member **200** seen from a first main surface side. FIG. **4**B is a diagram showing the holder member **200** seen from a second main surface side.

FIG. **4**C is a cross-sectional view of FIG. **4**A taken along X-X'. FIG. **4**D is a side view of the holder member **200**.

On the holder member **200**, a first surface **210** and a second surface **250**, which is on the opposite side of the holder member **200** from the first surface **210**, are formed; the holder member **200** is a member made of synthetic resin such as ABS resin. In a first row **211** of the first surface **210** of the holder member **200**, pulled-out tab insertion holes **215** are formed side by side from top to bottom as shown in FIG. **4**A. Similarly, in a second row **212** of the first surface **210**, pulled-out tab insertion holes **215** are formed side by side from top to bottom. When a unit battery **100** is attached to the holder member **200**, the pulled-out tab insertion holes **215** provided on the first surface **210** are used. The pulled-out tab insertion holes **215** are holes passing therethrough from the first surface **210** to the second surface **250**; and holes into which the pulled-out tabs of the unit battery **100** can be inserted.

As shown in FIG. **4**A, on the upper and lower sides of the first and second rows **211** and **212**, pulled-out tab guide ribs **203** are provided. A pulled-out tab guidance section **213** is provided in such a way that the pulled-out tab guidance section **213** is sandwiched between the pulled-out tab guide ribs **203** of the first row **211**. Moreover, a pulled-out tab guidance concave section **214** is provided in such a way that the pulled-out tab guidance concave section **214** is sandwiched between the pulled-out tab guide ribs **203** of the second row **212**.

In the first row **211**, based on regulations by the pulled-out tab guide ribs **203**, a pulled-out tab of an edge-side unit battery **100**, out of a plurality of unit batteries **100** connected in series, is guided to the second surface **250** from the first surface **210** via the pulled-out tab guidance section **213**.

In the second row **212**, based on regulations by the pulled-out tab guide ribs **203**, a pulled-out tab of an edge-side unit battery **100**, out of a plurality of unit batteries **100** connected in series, is guided to the second surface **250** from the first surface **210** via the pulled-out tab guidance concave section **214**.

Among a plurality of unit batteries **100** connected in series, a pulled-out tab of a unit battery **100** that is not on the edge sides (which are the upper and lower sides of the holder member **200** as shown in FIG. **4**A) passes through the pulled-out tab insertion hole **215** and is attached to the holder member **200**. In the upper and lower areas of the pulled-out tab insertion hole **215** (as shown in FIG. **4**A), pulled-out tab guide projecting sections **220** are provided in such a way that the pulled-out tab insertion hole **215** is sandwiched between the pulled-out tab guide projecting sections **220**, which are positioned on the upper and lower sides of the pulled-out tab insertion hole **215**. The pulled-out tab guide projecting sections **220** are generally made up of a top section **221** and two tapered sides **222**, which are seamlessly connected to the top section **221**. When a pulled-out tab of a unit battery **100** is inserted into a pulled-out tab insertion hole **215**, a space between the two tapered sides **222** becomes gradually narrower, making it easy to attach the unit battery **100** to the holder member **200**. Therefore, it is possible to improve efficiency in connecting a plurality of unit batteries **100** in series and increase productivity.

A flat surface between two upper and lower pulled-out tab guide projecting sections **220** serves as a bumping section **230**: the bumping section **230** regulates the position of the first end portion **111** as the first end portion **111** of the unit battery **100** comes in contact with the bumping section **230** at a time when the pulled-out tab of the unit battery **100** is inserted into the pulled-out tab insertion hole **215**.

The bumping sections **230** enable the unit batteries **100** to be easily positioned in the stacking direction as the first end portions **111** of the unit batteries **100** come in contact with the bumping sections **230**. Therefore, it is possible to improve efficiency in producing the battery pack and increase productivity.

Incidentally, according to the present embodiment, the bumping sections **230** are flat surfaces. However, the bumping sections **230** are not necessarily limited to such a shape. The bumping sections **230** can take any shape as long as it is possible to regulate the position of the first end portions **111** of the unit batteries **100**.

Among a plurality of unit batteries **100** connected in series, the unit batteries **100** disposed in both end portions cannot be handled by the above bumping sections **230** in such a way that the positions of the first end portions **111** of the unit batteries **100** are regulated. Instead, the first end portions **111** come in contact with the pulled-out tab guide ribs **203** so that the unit batteries **100** disposed in both end portions are positioned. A surface, with which the first end portion **111** comes in contact, of the pulled-out tab guide rib **203** and a bumping portion **230** are provided on the same plane.

To the second surface **250** of the holder member **200**, a board **300** can be attached. On the board **300**, the pulled-out tabs of the adjacent unit batteries **100** are bent, put on each other and connected, resulting in an electrical connection. When the pulled-out tabs of the adjacent unit batteries **100** are connected, it is preferred that the pulled-out tabs be mechanically bound together with connection members, such as bolts and nuts. Accordingly, in the example shown in FIG. **4**B, six nut housing sections **255** for housing nuts **256** are provided in the first row **211** of the second surface **250**, and five in the second row **212**. Moreover, on the second surface **250**, divider pieces **260**, which are designed to ensure insulation between the pulled-out tab connection sections of a unit battery **100** that are formed on the board **300** or between pulled-out tab connection sections and pulled-out tabs, are provided at three locations in the first row **211** and at two locations in the second row **212**.

Positioning projecting sections **263** are projections that help position the board **300** when the board **300** is attached to the holder member **200**; one positioning projection section **263** is positioned in the first row **211**, and the other in the second row **212**. Moreover, one screw hole **270**, which is used to bind the board **300** and the holder member **200** together after the board **300** is attached to the holder member **200** with the use of the above positioning projecting sections **263**, is provided in the first row **211**, and the other in the second row **212**. In the example here, bolts and nuts are used as the connection members. However, instead of bolts and nuts, caulking pins, rivets or other tools may be used as the connection members.

FIG. **5** is a perspective view of the holder member **200**, which is used to make the battery pack according to the embodiment of the present invention. Eight pulled-out tab insertion holes **215** are provided in the first row **211** of the second surface **250** of the holder member **200**. Similarly, eight pulled-out tab insertion holes **215** are provided in the second row **212**. A structure between the adjoining pulled-out tab insertion holes **215** in each row is made of the same resin as that of the main unit and is formed integrally with the main unit. The structure is referred to as a bridging structure section **251**.

One main feature of the present embodiment is to give the bridging structure section **251** various functions.

For example, as for the bridging structure section **251** shown in FIG. **5**A, a nut housing section **255** for housing a nut **256** is provided in the bridging structure section **251**. The bridging structure section **251** described above is effective in increasing the rigidity of the holder member **200**, and can provide a space in which the nut **256** is stored. Therefore, it is possible to make effective use of the space.

Moreover, for example, in the bridging structure section **251** shown in FIG. **5**B, a divider piece **260** is provided so as to be disposed between the pulled-out tab connection sections. The bridging structure section **251** described above is effective in increasing the rigidity of the holder member **200**, and can provide a space in which the divider piece **260** stands. Therefore, it is possible to make effective use of the space.

Moreover, for example, in the bridging structure section **251** shown in FIG. **5**C, a positioning projecting section **263**, which is used in positioning the board **300** and the holder member **200**, is provided. The bridging structure section **251** described above is effective in increasing the rigidity of the holder member **200**, and can provide a space in which the positioning projecting section **263** stands. Therefore, it is possible to make effective use of the space.

Moreover, for example, in the bridging structure section **251** shown in FIG. **5**D, a screw hole **270**, into which a board fixing screw **271** is screwed to fix the board **300** to the holder member **200**, is provided. The bridging structure section **251** described above is effective in increasing the rigidity of the holder member **200**, and can provide a space for the screw hole **270**. Therefore, it is possible to make effective use of the space.

The following describes the configuration of the board **300** on which connection sections for the pulled-out tabs of a plurality of unit batteries **100** are formed in the battery pack of the embodiment of the present invention. FIG. **6** is a perspective view of the board **300** that is used in connecting unit batteries **100** in series in the battery pack of the embodiment of the present invention.

The board **300**, which is made by mainly using glass epoxy or the like as base material, is attached to the second surface **250** of the holder member **200** before being used. The peripheral shape of the board **300** substantially matches the peripheral shape of the second surface **250** of the holder member **200**. At two locations on the periphery of the board **300**, pulled-out tab guidance notch sections **314** are formed so as to correspond to the pulled-out tab guidance concave sections **214** of the holder member **200**.

Moreover, on the board **300**, pulled-out tab extraction holes **315** are provided so as to correspond to the pulled-out tab insertion holes **215** of the holder member **200**. Moreover, on the board **300**, divider piece extraction holes **317** are provided so as to correspond to the divider pieces **260** of the holder member **200**. Furthermore, on the board **300**, pulled-out tab/divider piece extraction holes **316** are provided to support both the pulled-out tab insertion holes **215** and divider pieces **260** of the holder member **200**. The above holes are all through-holes that pass through the board **300** from one main surface to the other main surface; and are so formed that the pulled-out tabs of unit batteries **100**, the divider pieces **260** and the like can be inserted therein.

In areas where the pulled-out tabs of unit batteries **100** are fixed to the board **300** through connection members, the following sections are provided: thin-film electrode sections **320***a*, **320***b* and **320***c*. It is preferred that bolts and nuts be used in combination as connection members; the reason is that with bolts and nuts, the pulled-out tabs are easily and firmly fixed to the board **300**. However, instead of bolts and nuts, caulking pins, rivets or other tools may be used as the connection members.

There is an electrical connection between a thin-film electrode section **320***a* and a metallic positive electrode washer **321**, which is fixed to the board **300**. There is an electrical connection between a thin-film electrode section **320***c* and a metallic negative electrode washer **322**, which is fixed to the board **300**. To the positive electrode washer **321** and the negative electrode washer **322**, the pulled-out tabs of an edge portion of a unit battery **100** that is connected in series are connected. Therefore, the positive electrode washer **321** and the negative electrode washer **322** are used as terminals for charge and discharge of power for the battery pack.

Moreover, there is an electrical connection between a thin-film electrode section **320***b* and a terminal section, not shown, of a connector **340**, allowing the potential for monitoring each unit battery **100** to be measured through the connector **340**. Incidentally, the connector **340** may be formed so that a signal from a temperature measurement sensor (not shown) that measures temperatures of unit batteries **100** can be taken out.

For each of the thin-film electrode sections **320***a*, **320***b* and **320***c*, pulled-out tab connection screw holes **325** are provided: pulled-out tab connection bolts **257**, which are used to fix the pulled-out tabs of unit batteries **100**, are inserted into the pulled-out tab connection screw holes **325**. To the thin-film electrode section **320***a* and the thin-film electrode section **320***c*, one pulled-out tab of an edge-portion unit battery **100**, out of the unit batteries **100** connected in series, is fixed. Meanwhile, two thin-film electrode sections **320***b* are fixed in such a way that the pulled-out tabs of the adjoining unit batteries **100** are bent and put on each other.

On the board **300**, two positioning holes **328** are formed so as to correspond to the positioning projecting sections **263** provided on the second surface **250** of the holder member **200**. As the two positioning projecting sections **263** pass through the positioning holes **328**, the holder member **200** and the board **300** can be easily positioned when being bound together, contributing to an improvement in productivity. Moreover, board fixing screw holes **329**, which are formed on the board **300**, are holes into which board fixing screws **271**, which are used to fix the holder member **200** to the board **300**, are inserted.

In the battery pack of the present invention, with the use of not only the board **300** but also the holder member **200**, which is formed integrally with the board **300**, the adjacent unit batteries **100** are connected. As a result, the unit batteries **100** are connected in series. According to the above configuration, the pulled-out tabs are tightly fixed between both surfaces of the board **300** with the help of connection members, such as bolts and nuts. Moreover, on a surface that is on the opposite side of the board **300** from a surface to which the tabs are fixed, the pulled-out tab guide projecting sections **220** ensure insulation between the pulled-out tabs of the unit battery **100**. Thus, it is possible to provide a highly reliable battery pack.

The following describes a battery protective member **400**, which protects a plurality of unit batteries **100** at a time when the unit batteries **100** are connected in series and turned into a battery connecting structure **500** in the battery pack of the embodiment of the present invention. FIGS. **7**A and **7**B are diagrams illustrating the battery protective member **400**, which is used to form the battery pack of the embodiment of the present invention. FIG. **7**A is a diagram showing the battery protective member **400** in a way that faces a flat-plate section **410** to which a main surface of a unit battery **100** is bonded. FIG. **7**B is a diagram showing the battery protective member **400** seen from an upper side of FIG. **7**A.

For example, the battery protective member **400** is made of synthetic resin, such as ABS resin. When unit batteries **100** are stacked, the battery protective member **400** is inserted between the unit batteries **100** stacked before being used. The flat-plate section **410** of the battery protective member **400** is a member sandwiched between a unit battery **100** and a unit battery **100** that is connected in series to the unit battery **100**. Meanwhile, protection-side plate sections **440** are so provided as to extend in a direction perpendicular to the flat-plate section **410** from both edge portions of the flat-plate section **410**. Therefore, as shown in FIG. **7**B, the cross-sectional surface of the battery protective member **400** is in the shape of "H."

Moreover, a notch section **420**, which is made up of the following, is formed on the flat-plate section **410**: a first notch section **421**, which is the deepest notch section; second notch sections **422**, which are disposed on both sides of the first notch section **421** and are the second deepest notch sections after the first notch section **421**; and third notch sections **423**, which are disposed on both sides of the second notch sections **422** and are the shallowest notch sections.

The following describes processes of producing, from each of the above members, a battery connecting structure **500** in which unit batteries **100** are connected, with reference to FIGS. **8** to **18**. FIGS. **8** to **18** are diagrams illustrating the processes of producing the battery connecting structure **500**, which makes up the battery pack of the embodiment of the present invention.

First, in a process shown in FIG. **8**, nuts **256** are mounted in all the nut housing sections **255**, which are provided on the second surface **250** of the holder member **200**. The dimensions of the inner periphery of the nut housing sections **255** are so set that the nuts **256** cannot be easily removed once the nuts **256** are placed into the nut housing sections **255**.

In a subsequent process shown in FIG. **9**, the positioning projecting sections **263** of the holder member **200** are inserted into the positioning holes **328** of the board **300** so that the holder member **200** and the board **300** are positioned. Subsequently, two board fixing screws **271** are inserted into the board fixing screw holes **329** and screwed into screw holes **270**. As a result, the holder member **200** is fixed to the board **300**. Incidentally, for the board fixing screw holes **329**, various kinds of screw can be used. However, the use of tapping screws helps improve work efficiency during the production process.

In a subsequent process shown in FIG. **10**, a unit battery **100** is disposed on the first surface **210** of the holder member **200**. The unit battery **100** is positioned as the first end portion **111** of the unit battery **100** collides with the pulled-out tab guide rib **203**. The negative-electrode pulled-out tab **130** of the unit battery **100** is then bent so as to come in contact with the thin-film electrode section **320***b* of the board **300** with the help of the pulled-out tab guidance concave section **214**. Moreover, the positive-electrode pulled-out tab **120** of the unit battery **100** is bent so as to come in contact with the thin-film electrode section **320***a* of the board **300** with the help of the pulled-out tab guidance section **213**. The pulled-out tab connection bolts **257** are inserted into the holes **127** of the positive-electrode pulled-out tab **120** and the pulled-out tab connection screw holes **325**; the pulled-out tab connection bolts **257** are screwed into the nuts **256** housed in the nut housing sections **255**. In this manner, the process of mounting the first unit battery **100** is completed.

A subsequent process shown in FIG. **11** takes place on the first surface **210** of the holder member **200**. In the process, as shown in the diagram, two strips of two-sided adhesive tape **460** are attached to an upper main surface of the unit battery **100**. The two-sided adhesive tapes **460** are used to fix the first unit battery **100**, which is attached to the holder member **200**, to a second unit battery **100**, which is to be attached to the holder member **200**. The reason the two strips of two-sided adhesive tape **460** are provided on the main surface of the unit battery **100** as shown in the diagram is to allow a spacer, described later, to be disposed between the two strips of two-sided adhesive tape **460** in order to improve productivity.

In a subsequent process shown in FIG. **12**, a spacer (not shown) that is thicker than the two-sided adhesive tapes **460** is placed on the first unit battery **100** attached. Furthermore, two pulled-out tabs of the second unit battery **100** are inserted into the pulled-out tab insertion holes **215** as the second unit battery **100** slides on the spacer. As described above, the pulled-out tab guide projecting sections **220** are disposed on the upper and lower sides of the two pulled-out tab insertion holes **215**. Furthermore, the tapered sides **222** are provided on the pulled-out tab guide projecting sections **220**. Therefore, a space between the upper and lower pulled-out tab guide projecting sections **220** becomes gradually narrower, enabling the pulled-out tabs of a unit battery **100** to be easily guided to the pulled-out tab insertion holes **215** of the holder member **200**.

The bumping section **230** between the upper and lower pulled-out tab guide projecting sections **220** comes in contact with the first end portion **111** of the unit battery **100** as the pulled-out tabs (**120**, **130**) of the unit battery **100** are inserted into the pulled-out tab insertion holes **215**. Thus, the position of the first end portion **111** is regulated. In the holder member **200**, such a bumping section **230** is provided. Therefore, it is easy to position a unit battery **100** in the stacking direction as the first end portion **111** of the unit battery **100** comes in contact with the bumping section **230**. Thus, it is possible to increase efficiency in producing the battery pack and improve productivity.

After the first end portion **111** comes in contact with the bumping section **230** as described above, the spacer is removed. As a result, the first unit battery **100** attached and the second unit battery **100** attached are bonded together with the two-sided adhesive tape **460**.

According to the present embodiment, two strips of two-sided adhesive tape **460** are attached to the main surface of the unit battery **100**, and are used to bond unit batteries **100** together, thereby providing the battery pack with resistance to vibration. Preferred conditions for the above purpose will be described below.

FIGS. **27**A and **27**B are diagrams illustrating conditions for bonding unit batteries **100** together. FIG. **27**A is a diagram showing the dimensions of a unit battery **100** that is used in the battery pack of the present embodiment. FIG. **27**B is a diagram showing the dimensions of a two-sided adhesive tape **460** that is used in bonding unit batteries **100**, which are used in the battery pack of the present embodiment.

As for the unit battery **100**, the first end portion **111** is 82 mm in length. The side end portion **113** is 150 mm in length. Moreover, chamfered portions **119** are formed on both corner portions of the second end portion **112**. Therefore, the outer circumference thereof is 459 mm in length.

Here, an electrode laminated area **105** in the unit battery **100** is defined. The electrode laminated area **105** is an area corresponding to a location where an electrode laminated body is stored: the electrode laminated body includes the sheet positive electrodes, sheet negative electrodes and separators, which are stored in the hermetically sealed unit battery **100** in a laminate film casing material. That is, the electrode laminated area **105** stores the electrode laminated body and therefore serves as a major flat surface area corresponding to a bulging portion of the laminate film casing material. The electrode laminated area **105** is a shaded area in FIG. **2**, which is a perspective view of the unit battery **100**. The electrode laminated area **105** is substantially in the shape of a rectangle: the long sides thereof are 131 mm in length, the short sides are 69 mm in length, and the outer circumference of the electrode laminated area **105** is 400 mm in length.

In a process of making the battery pack of the present embodiment, the two-sided adhesive tape **460** is used to bond the unit batteries **100** together. The dimensions of the two-sided adhesive tape **460** are as follows: the long sides are 100 mm in length, the short sides are 12 mm in length, and the outer circumference of one strip of two-sided adhesive tape **460** is 224 mm in length. According to the present embodiment, two strips of two-sided adhesive tape **460** are used. Therefore, the total outer circumference of the two-sided adhesive tapes **460** used to bond the batteries together is 448 mm in length.

A feature of the present embodiment is that the total outer circumference of the two-sided adhesive tapes **460** is set longer than the outer circumference of the electrode laminated area **105**, which is an area corresponding to a location where the electrode laminated body is stored in the laminate film casing material. The above setting leads to an excellent result in a vibration test.

In the above-described battery pack of the present invention, the total outer circumference of the two-sided adhesive tapes **460** set longer than the outer circumference of the electrode laminated area **105**, which is an area corresponding to a location where the electrode laminated body is stored in the laminate film casing material of the unit battery **100**. Therefore, even when vibrations are applied, the unit batteries are not separated. Moreover, no stress is applied to a connection portion where pulled-out tabs are connected. Thus, it is possible to increase reliability. In addition, compared with the case where the batteries are bonded together in the strongest way, i.e. the case where the entire surfaces of the areas corresponding to the locations for storing electrode laminated bodies are bonded together, the stress that occurs at an end portion of a two-sided adhesive tape can be dispersed. Therefore, even when vibrations are applied to the battery pack, the laminate film casing material is less likely to suffer damage.

Incidentally, according to the present embodiment, to satisfy the above conditions, two strips of two-sided adhesive tape **460** are used. However, the two-sided adhesive tapes **460** are not limited to the form described above, as long as the total outer circumference of the two-sided adhesive tapes **460** is set longer than the outer circumference of the electrode laminated area **105** in the laminate film casing material of the unit battery **100**. For example, a plurality of circular, patch-like two-sided adhesive tapes may be provided to increase the total outer circumference, thereby making it possible to meet the above conditions and improve productivity. Hereinafter, other examples of two-sided adhesive tapes **460** will be described as to shape.

FIGS. **28**A and **28**B are diagrams illustrating another example of conditions for bonding unit batteries **100** together. FIG. **28**A is a diagram showing the dimensions of a unit battery **100** that is used in the battery pack of the present embodiment. FIG. **28**B is a diagram showing the dimensions of a two-sided adhesive tape **460** that is used in bonding together unit batteries **100**, which are used in the battery pack of the present embodiment. The dimensions of the unit battery **100** are the same as those shown in FIG. **27**A.

In the example shown in FIGS. **28**A and **28**B, in a process of making the battery pack, the dimensions of the two-sided adhesive tape **460**, which is used to bond the unit batteries **100** together, are as follows: the long sides are 100 mm in length, the short sides are 6 mm in length, and the outer circumference of one strip of two-sided adhesive tape **460** is 212 mm in length. In the example shown in FIGS. **28**A and **28**B, three strips of two-sided adhesive tape **460** are used. Therefore, the total outer circumference of the two-sided adhesive tapes **460** used for bonding batteries together is 636 mm in length, and can be set longer than the outer circumference of the electrode laminated area **105**, which is 400 mm in length. In this manner, even under the bonding conditions shown in FIGS. **28**A and **28**B, it is possible to achieve similar advantageous effects to those in the above-described embodiment.

FIGS. **29**A and **29**B are diagrams illustrating another example of conditions for bonding unit batteries **100** together. FIG. **29**A is a diagram showing the dimensions of a unit battery **100** that is used in the battery pack of the present embodiment. FIG. **29**B is a diagram showing the dimensions of a two-sided adhesive tape **460** that is used in bonding together unit batteries **100**, which are used in the battery pack of the present embodiment. The dimensions of the unit battery **100** are the same as those shown in FIG. **27**A.

In the example shown in FIGS. **29**A and **29**B, in a process of making the battery pack, the two-sided adhesive tape **460**, which is used to bond the unit batteries **100** together, is circular in shape with a diameter of 30 mm, and the outer circumference thereof is about 94.2 mm in length. In the example shown in FIGS. **29**A and **29**B, the number of such circular two-sided adhesive tapes **460** used is six. Therefore, the total outer circumference of the two-sided adhesive tapes **460** used for bonding batteries together is 565.2 mm, and can be set longer than the outer circumference of the electrode laminated area **105**, which is 400 mm in length. In this manner, even under the bonding conditions shown in FIG. **29**, it is possible to achieve similar advantageous effects to those in the above-described embodiment.

The following describes preferred bond strength at a time when the unit batteries **100** are bonded together with the two-sided adhesive tapes **460**. Even in the following description, the relationships of dimensions shown in FIGS. **27**A and **27**B are used.

The adhesive power of the two-sided tape **460** used in the present embodiment is 0.98 N/mm. Therefore, when two strips of two-sided adhesive tape **460**, whose long sides are 100 mm in length and whose short sides are 12 mm in length, are used, the bond strengths (tensile strengths) for bonding unit batteries **100** together in the long-side and short-side directions are as follows.

Long-side direction: 0.98 (N/mm)×12 (mm)×2 (strips)=24N

Short-side direction: 0.98 (N/mm)×100 (mm)×2 (strips)=98N

Meanwhile, the adhesive power of a fusion-bonding portion of the laminate film casing material of the unit battery **100** is 1.5 N/mm. Incidentally, in the unit battery **100** shown in FIG. **27**, the narrowest fusion-bonding portion is 5 mm in width. Given the above, the minimum bond strengths of the fusion-bonding portion of the laminate film casing material of the unit battery **100** in the long-side and short-side directions are as follows.

Long-side direction: 1.5 (N/mm)×5 (mm)×2 (sides)=15N

Short-side direction: 1.5 (N/mm)×5 (mm)×2 (strips)=15N

The maximum bond strengths of the fusion-bonding portion of the laminate film casing material of the unit battery **100** in the long-side and short-side directions are as follows.

Long-side direction: 1.5 (N/mm)×82 (mm)=123N

Short-side direction: 1.5 (N/mm)×150 (mm)=225N

According to the present embodiment, the bond strength for bonding the unit batteries **100** together using the two-sided adhesive tapes **460** is set larger than the minimum bond strength of the fusion-bonding portion. Accordingly, when the battery pack is disassembled and the unit batteries **100** are taken out, the fusion-bonding portion of a unit battery **100** is ripped up. As a result, the unit battery **100** becomes unavailable, thereby averting the risk that the unit battery **100** taken out will be reused.

In this case, the positive-electrode pulled-out tab **120** of the first unit battery **100** attached to the holder member **200** is disposed in the first row **211**, and the negative-electrode pulled-out tab **130** in the second row **212**. On the other hand, the positive-electrode pulled-out tab **120** of the second unit battery **100** attached to the holder member **200** is disposed in the second row **212**, and the negative-electrode pulled-out tab **130** in the first row **211**. Hereinafter, in a process of sequentially placing unit batteries **100**, the positive-electrode pulled-out tabs **120** of the odd unit batteries **100** attached are disposed in the first row **211**, and the negative-electrode pulled-out tabs **130** in the second row **212**. The positive-electrode pulled-out tabs **120** of the even unit batteries **100** attached are disposed in the second row **212**, and the negative-electrode pulled-out tabs **130** in the first row **211**. In this manner, in the direction in which the unit batteries **100** are stacked, the unit batteries **100** are so disposed that the pulled-out tabs of the adjacent unit batteries **100** face different directions. Accordingly, on the board **300**, connection does not have to take place diagonally with respect to the stacking direction.

After it is confirmed that the first end portion **111** of the second unit battery **100** is pushed into until the first end portion **111** hits the first surface **210** of the holder member **200**, a subsequent task starts on the board **300**.

In a subsequent process shown in FIG. **13**, the positive-electrode pulled-out tab **120** of the second unit battery **100** attached is bent downward as shown in the diagram, and is put on the negative pulled-out electrode **130** of the first unit battery **100** attached. After that, a pulled-out tab connection bolt **257** is inserted into a hole of each pulled-out tab, or a pulled-out tab connection screw hole **325**, and is screwed into a nut **256**, forming a connection portion for the negative-electrode pulled-out tab **130** of the first unit battery **100** attached on the thin-film electrode section **320***b* and the positive-electrode pulled-out tab **120** of the second unit battery **100** attached. In this manner, an electrical connection is completed.

Meanwhile, the negative-electrode pulled-out tab **130** of the second unit battery **100** attached is bent upward as shown in the diagram, thereby making preparations for the positive-electrode pulled-out tab **120** of the third unit battery **100** attached to be connected.

In a subsequent process shown in FIG. **14**, in a similar way to the case where the second unit battery **100** is attached, a battery protective member **400** is attached with the use of a spacer. The upper surface of the second unit battery **100** and the lower surface of the battery protective member **400** are bonded together with two strips of two-sided adhesive tape **460**. Furthermore, as shown in the diagram, two strips of two-sided adhesive tape **460** are attached to the upper surface of the battery protective member **400**. With the use of the two-sided adhesive tapes **460**, the battery protective member **400** is fixed to the third unit battery **100** attached to the holder member **200**.

The battery protective member **400** is attached to the unit battery **100** in such a way that there is a space of about 2 mm between the second notch sections **422** or third notch sections **423** and the holder member **200**. The space makes it difficult for the vibrations or shocks delivered to the battery pack to spread to the positive-electrode pulled-out tab **120** and the negative-electrode pulled-out tab **130**, thereby improving the reliability of electric connection of the battery pack.

Incidentally, if the vibrations or shocks delivered to the battery pack are expected to be small, the space may not be provided. In this case, the battery protective member **400** can be attached to the unit battery **100** after the battery protective member **400** is pushed into until the second notch sections **422** or third notch sections **423** hit the holder member **200**. Since the battery protective member **400** is attached to the unit battery **100** as described above, it is easy to position the battery protective member **400** in the stacking direction.

FIG. **15** shows the situation where the third to eighth unit batteries **100** are sequentially attached to the holder member **200** and the board **300** in a similar way to that described above. On the board **300**, each time one unit battery **100** is attached, the pulled-out tabs are bent and put on each other, and the pulled-out tabs of the adjacent unit batteries **100** are connected by means of the pulled-out tab connection bolts **257**. In this manner, an electrical connection is realized.

In a subsequent process shown in FIG. **16**, what is shown is the situation where, after the eighth unit battery **100** is attached, still another battery protective member **400** is attached. In this manner, in the battery connecting structure **500** of the present embodiment, two battery protective members **400** are disposed. In this manner, each unit battery **100** is protected against external shocks and the like.

FIG. **17** shows the situation where, on the battery protective member **400**, the ninth and tenth unit batteries **100** are further attached to the holder member **200** and the board **300**. The negative-electrode pulled-out tab **130** of the tenth unit battery **100** is bent so as to come in contact with the thin-film electrode section **320***c* of the board **300** with the use of the pulled-out tab guidance section **213**, and is fixed to the thin-film electrode section **320***c* with the use of the pulled-out tab connection bolt **257**. As a result, the pulled-out tabs of the first to tenth unit batteries **100** are each connected on the board **300**, and a process of connecting ten unit batteries **100** in series is completed. A process of charging and discharging the ten unit batteries **100** connected in series can be performed through the positive electrode washer **321** and the negative electrode washer **322**. A terminal member **331** is attached to the positive electrode washer **321**, and a terminal member **332** to the negative electrode washer **322**. In this manner, the battery connecting structure **500** is completed.

As described above, the battery pack of the present invention is made in the following manner: the positive-electrode and negative-electrode pulled-out tabs of a plurality of unit batteries **100** are inserted into the pulled-out tab insertion holes **215** of the holder member **200**, and the pulled-out tabs having different polarities of a plurality of the unit batteries **100** are connected together on the board **300**. Therefore, the production of battery packs is highly efficient, resulting in an improvement in productivity.

Moreover, the pulled-out tabs having different polarities of a plurality of the unit batteries **100** are connected together on the board **300** with pulled-out tab connection bolts **257** and nuts **256**. Therefore, it is easy to connect a plurality of unit batteries **100** electrically. Thus, the production of battery packs is highly efficient, resulting in an improvement in productivity.

A feature of each connection section of the battery connecting structure **500**, which is formed as described above, will be detailed.

On the board **300**, three kinds of thin-film electrode section are provided: thin-film electrode sections **320***a*, **320***b* and **320***c*.

Among the above thin-film electrode sections, the thin-film electrode section **320***a* is used to electrically connect the following components: the positive electrode washer **321**, which is provided on one end portion of the board **300**, and the positive-electrode pulled-out tab **120** of a unit battery **100**, which is attached to one end portion of the board **300**. That is, a connection section in the thin-film electrode section **320***a* functions as a positive-electrode pulled-out tab/positive electrode washer connection section.

As for the unit battery **100** that is attached to one end portion of the board **300**, as indicated by a bending direction b_1 and the like in FIG. **10**, the positive-electrode pulled-out tab **120** and negative-electrode pulled-out tab **130** thereof are both bent in the same direction.

The thin-film electrode section **320***c* is used to electrically connect the following components: the negative electrode washer **322**, which is provided on the other end portion that is different from one end portion of the board **300**, and the negative-electrode pulled-out tab **130** of a unit battery **100**, which is attached to the other end portion of the board **300**. That is, a connection section in the thin-film electrode section **320***c* functions as a negative-electrode pulled-out tab/negative electrode washer connection section.

Even as for the unit battery **100** that is attached to the other end portion of the board **300**, as indicated by a bending direction b_2 and the like in FIG. **18**, the positive-electrode pulled-out tab **120** and negative-electrode pulled-out tab **130** thereof are both bent in the same direction.

The thin-film electrode section **320***b* is used to electrically connect the following components: the positive-electrode pulled-out tab **120** of one unit battery **100**, which is not attached to both end portions of the board **300**, and the negative-electrode pulled-out tab **130** of the other unit battery **100**. That is, a connection section in the thin-film electrode section **320***b* functions as a pulled-out tab connection section for connecting together the pulled-out tabs having different polarities of a plurality of unit batteries **100**.

As for the unit battery **100** that is not attached to both end portions of the board **300** but relies on the above pulled-out tab connection section for the pulled-out tabs to be connected, as indicated by the bending directions b_1, b_2 and the like in FIG. **13**, the positive-electrode pulled-out tab **120** and the negative-electrode pulled-out tab **130** are bent in opposite directions.

The following describes a feature of the divider piece **260** on the battery connecting structure **500**, which is formed as described above. For example, as shown in FIG. **13**, in a connection section for the pulled-out tabs (**120**, **130**), the height h_1 of the divider piece **260** from the board **300** is designed so as to be higher than the height h_2 of the pulled-out tab connection bolt **257**, which is used to connect the pulled-out tabs (**120**, **130**). The above dimensional relationship is satisfied not only in the area shown in FIG. **13**, but also for the height of all the divider pieces **260** and the height of pulled-out tab connection bolts **257** in all the connection sections.

Since the above configuration is employed, for example, even when a conductive member approaches the board **300** of the battery connecting structure **500**, the divider pieces **260** serve as shields. Therefore, the conductive member does not cause the pulled-out tab connection bolts **257** of the adjacent connection sections to be short-circuited (For example, the pulled-out tab connection bolt **257** of a connection section C_1 shown in FIG. **18** and the pulled-out tab connection bolt **257** of a connection section C_2 are not short-circuited; or alternatively, the pulled-out tab connection bolt **257** of a connection section C_3 and the pulled-out tab connection bolt **257** of a connection section C_4 are not short-circuited).

In addition to the above advantageous effects, there are the following advantageous effects. In a process of producing the battery connecting structure **500**, the pulled-out tabs (**120**, **130**) of a unit battery **100** are inserted into the pulled-out tab insertion holes **215** before being attached. Then, on the board **300**, the pulled-out tabs (**120**, **130**) are bent. In this case, since there is the divider piece **260**, the following production mistake is not made: the pulled-out tabs (**120**, **130**) are bent in a direction opposite to an original direction in which the pulled-out tabs should be bent. Moreover, even if the pulled-out tabs (**120**, **130**) are bent in the direction opposite to the original direction, the tabs do not go beyond the divider piece **260** to reach a connection section that is not the original connection section, because the length of the pulled-out tabs (**120**, **130**) and the height of the divider piece **260** are so set as to avoid an unwanted electrical connection.

The following describes processes of making a battery pack of the present invention using the battery connecting structure **500**, which is formed as described above, with reference to FIGS. **19** to **26**.

In a process shown in FIG. **19**, to a first case body **600** that houses the battery connecting structure **500**, a discharge terminal **613** and a charge terminal **614** are fixed with screws with the help of a discharge terminal attachment concave section **611** and a charge terminal attachment concave section **612**, which are provided on the first case body **600**.

In a process shown in FIG. **20**, a first cushioning member **621** is attached to a second housing section **602** of the first case body **600** with an adhesive or the like, and a second cushioning member **622** to a circuit housing section **603**.

In a process shown in FIG. **21**, to a second housing section **662** of a second case body **660**, a third cushioning member **663** is attached with an adhesive or the like.

In processes shown in FIGS. **22** and **23**, to the battery connecting structure **500**, cushioning materials are attached. In the battery pack of the present invention, two structures, i.e. a first battery connecting structure **500** and a second battery connecting structure **500**, are stored in the battery pack. The first battery connecting structure **500** and the second battery connecting structure **500** are connected in parallel before being used.

In a process shown in FIG. **22**, as for the first battery connecting structure **500**, fourth cushioning members **504**, which are thick, are attached to an edge-portion unit battery **100**; to all protective-side plate sections, fifth cushioning members **505**, which are thinner than the fourth cushioning members **504**, are attached. An adhesive or the like is used in attaching the fourth cushioning members **504** and the fifth cushioning members **505** to parts. In this case, a thermistor **530** (not shown in FIG. **22**), which is temperature detection means in the battery pack, is attached only to the first battery connecting structure **500**. The thermistor **530** detects a temperature of the first battery connecting structure **500** and transmits a detection signal thereof to a protective circuit board **700**.

Meanwhile, in a process shown in FIG. **23**, as for the second battery connecting structure **500**, fourth cushioning members **504** are attached to an edge-portion unit batter **100**; only to a one-side protective-side plate section, fifth cushioning members **505** are attached. As in the case described above, an adhesive or the like is used in attaching the fourth cushioning members **504** and the fifth cushioning members **505** to parts.

In a process shown in FIG. **24**, a discharge terminal **613**, a charge terminal **614**, a thermistor **530** and a protective circuit board **700** are connected with wires. Moreover, the protective circuit board **700** is fixed to the circuit housing section **603** of the first case body **600** with screws.

In a process shown in FIG. **25**, the first and second battery connecting structures **500** are connected to the protective circuit board **700** with wires. Moreover, the first battery connecting structure **500** is stored in the first housing section **601** of the first case body **600**, and the second battery connecting structure **500** in the second housing section **602**.

In a process shown in FIG. **26**, the first case body **600** is fixed to the second case body **660** with screws. As a result, a battery pack **800** of the present invention is completed.

Here, the temperature detection means in the battery pack **800** of the present invention will be described. As described above, the battery pack **800** of the present invention is formed in such a way that two battery connecting structures **500** are stored in the same case bodies **600** and **660**. However, as shown in FIG. **26**, among the two battery connecting structures 500, the thermistor 530 is provided, or attached, only on the first battery connecting structure 500 that is housed in the first housing section of the case body. Only temperature data, detected by the thermistor 530, are transmitted to a circuit provided on the protective circuit board 700, and are used to control batteries.

The reason the thermistor 530 is provided in the first battery connecting structure 500 among the two battery connecting structures 500 housed in the case bodies is that in the battery pack 800 that is positioned for use, the first battery connecting structure 500 is disposed at a vertically higher position than the second battery connecting structure 500, which is disposed at a lower position, and that the first battery connecting structure 500 is in an environment where temperatures could easily rise. FIG. 30 is a diagram showing how the battery pack 800 of the embodiment of the present invention is positioned when being used as a source of power for a bicycle.

In the battery pack 800 of the present invention, the thermistor 530 is attached to the first battery connecting structure 500, which is disposed in a vertically upper portion of the case body, in which temperatures could easily rise, and is under a thermally unfavorable condition. Temperature data are acquired from the thermistor 530. Based on the temperature data, control processes, such as a process of stopping discharging, take place on the protective circuit board 700. According to the above battery pack 800 of the present invention, it is possible to reduce the number of components and costs, as well as to simplify the configuration of a circuit that processes detection data of the thermistor 530.

Incidentally, according to the present embodiment, among the two battery connecting structures 500 provided in the case bodies, the thermistor 530 is provided in the battery connecting structure 500 that is positioned in a vertically upper portion when being used. However, the present invention can be applied to the case where three or more battery connecting structures 500 are provided in case bodies. That is, if three or more battery connecting structures 500 are stored in case bodies of a battery pack, the thermistor 530 is provided only on the battery connecting structure 500 that is disposed at the vertically highest position when being used.

The following describes the vibration resistance of the battery pack 800, which is formed as described above. The problem is that, if vibrations are continuously applied to the battery pack that is formed in such a way that unit batteries, which use a laminate casing material, are connected in series and stacked, a corner portion of the laminate film casing material of a unit battery could break through the laminate film casing material of an adjacent unit battery, causing the electrolytic solution or the like inside the unit battery to leak and the battery pack to break down. To solve the problem, one conceivable solution is to chamfer all the corner portions of the laminate films of the unit batteries. However, another problem arises that chamfering all the corner portions requires more production processes, resulting in a rise in production costs.

According to the present invention, while keeping the number of corner portions to be chamfered at a minimum level, it is possible to increase reliability in terms of vibration resistance. The configuration to achieve the above will be described below with reference to FIG. 1 again.

The electrode laminated body, which includes the sheet positive electrodes, sheet negative electrodes and separators, and an electrolytic solution are stored in the laminate film casing material, the periphery of which is then heat-sealed. As a result, the inside of the battery main unit 110 is hermetically closed. From the first end portion 111 on the periphery, the positive-electrode pulled-out tab 120 and the negative-electrode pulled-out tab 130 are taken out.

The following looks at the dimensional relationships of fusion-bonding portions formed by heat-sealing on the laminate film casing material. A fusion-bonding portion that is formed in the first end portion 111 and indicated by c is defined as a first fusion-bonding portion 117; a fusion-bonding portion that is formed in the second end portion 112 and indicated by d is defined as a second fusion-bonding portion 118. The fusion-bonding portions are both shaded in the diagram. The fusion-welding lengths of the first fusion-bonding portion 117 and second fusion-bonding portion 118 are both defined as lengths in a direction in which tabs are taken out.

In the unit battery 100 used in the present embodiment, compared with the first fusion-welding length c of the first fusion-bonding portion 117, the second fusion-welding length d of the second fusion-bonding portion 118 is set shorter. When the stacked unit batteries 100 are used, if a corner portion of the laminate film casing material of an adjacent unit battery 100 comes in contact with the first fusion-bonding portion 117 and rubs against the first fusion-bonding portion 117, the possibility is very low that the first fusion-bonding portion 117 would break. By contrast, if a corner portion of the laminate film casing material of an adjacent unit battery 100 comes in contact with the second fusion-bonding portion 118 and rubs against the second fusion-bonding portion 118, the possibility is relatively high that the second fusion-bonding portion 118 will break.

Therefore, according to the present embodiment, two second-end-side corner portions 116 in the second end portion 112 are chamfered to form chamfered portions 119 at both corner portions. As a result, even if vibrations are applied to the battery pack 800, the second-end-side corner portions 116, on which the chamfered portions 119 are formed, do not affect the second fusion-bonding portion 118 of an adjacent unit battery 100. Therefore, the leakage of electrolytic solution and other troubles do not occur, resulting in an increase in reliability.

On the other hand, in the first end portion 111, even if a first-end-side corner portion 115 of the laminate film casing material of an adjacent unit battery 100 comes in contact with the first fusion-bonding portion 117 and rubs against the first fusion-bonding portion 117 because of vibrations applied to the battery pack 800, the possibility is very low that the first fusion-bonding portion 117 would break. Thus, it is possible to curb an increase in the number of production processes without forming chamfered portions on the two first-end-side corner portions 115 of the first end portion 111.

The following describes a preferred dimensional relationship between the first fusion-welding length c and the second fusion-welding length d in producing the battery pack of the present invention.

The first fusion-welding length c of the unit battery 100 used in the present embodiment is 19±1 mm, and the second fusion-welding length d 6±1 mm. For any fusion-welding length, "±1 mm" means a manufacturing error. The above fusion-welding lengths are determined based on the following grounds.

First, in any fusion-bonding portion of the unit battery 100, it is desirable that the fusion-welding width thereof be greater than or equal to 5 mm in order to ensure the sealing characteristics of the laminate film casing material.

The second fusion-welding length d, which is a fusion-welding width of the second fusion-bonding portion 118, is set longer than required to 6±1 mm given a manufacturing tolerance and the like.

Moreover, when the first fusion-welding length c, which is a fusion-welding width of the first fusion-bonding portion **117**, is set to about 18 mm or more and when the battery pack is formed, the possibility is very low that the first fusion-bonding portion **117** would break even if the first-end-side corner portions **115** of adjacent unit batteries **100** rub against each other. Therefore, it is possible to increase the reliability of the battery pack. Thus, in the unit battery **100** of the present embodiment, the first fusion-welding length c is set longer than required to 19±1 mm given a manufacturing tolerance and the like.

Given the above, in order to set the dimensional relationship between the first fusion-welding length c and the second fusion-welding length d, a c/d value, which is obtained by dividing the first fusion-welding length c by the second fusion-welding length d, is calculated: $c/d=(19\pm1)/(6\pm1)$. The c/d value is preferably a predetermined value greater than, or equal to, a value that is obtained under the most unfavorable condition. Therefore, it is preferred that $c/d\geq(19-1)/(6+1)\approx2.5$. That is, in the battery pack of the present invention, the c/d value, obtained by dividing the first fusion-welding length c by the second fusion-welding length d, is preferably greater than or equal to 2.5.

In the above battery pack **800** of the present invention, there are chamfered portions **119** at both corner portions in the second end portion **112** whose fusion-welding length is short. Therefore, it is possible to curb an increase in the number of production processes when the battery pack **800** is being produced, as well as to prevent the breaking of the laminate films of adjacent unit batteries **100** even when the battery pack **800** is in use and exposed to vibrations. Thus, the leakage of electrolytic solution and other troubles do not occur, resulting in an increase in reliability.

Incidentally, according to the present embodiment, when the two second-end-side corner portions **116** of the second end portion **112** are chamfered, the chamfered portions **119** are formed by cutting the second-end-side corner portions **116** linearly. However, the second-end-side corner portions **116** may be cut in a way that draws an arc, forming the chamfered portions **119** having "R."

Moreover, according to the present embodiment, an example of the unit battery **100** has been described in such a way that fusion-bonding portions are provided on all the four sides of the laminate film casing material. However, the present invention is not limited to the above unit battery **100**. The present invention may be applied to a unit battery in which fusion-bonding portions are provided on three sides of the laminate film casing material. Such a unit battery **100** will be described with reference to FIG. **31**.

FIG. **31** is a diagram showing another example of a unit battery **100**, which makes up the battery pack **800**. A battery main unit **110** of the unit battery **100** shown in FIG. **31** has a structure in which the following components are stored in a laminate film casing material: an electrode laminated body, in which a plurality of sheet positive electrodes and a plurality of sheet negative electrodes are stacked via separators, and an electrolytic solution (both not shown). The laminate film casing material is folded back at the second end portion **112**, and three sides, i.e. the first end portion **111** and two side end portions **113**, are fusion-welded in total. The unit battery **100** is so formed that the electrode laminated body and the electrolytic solution are enclosed within the laminate film casing material.

Even when the above unit battery **100** is used, two second-end-side corner portions **116** in the second end portion **112** are chamfered to form chamfered portions **119** at both corner portions. Therefore, it is possible to achieve similar advantageous effects to those in the above-described case.

More specifically, even in the following battery pack, it is possible to achieve similar advantageous effects to those in the above-described case: a battery pack in which a plurality of unit batteries **100** is connected in series, with the unit batteries **100** including a positive-electrode pulled-out tab **120**, a negative-electrode pulled-out tab **130**, and a laminate casing member in which a first end portion **111**, from which the positive-electrode pulled-out tab **120** and the negative-electrode pulled-out tab **130** are pulled out, a second end portion **112**, which faces the first end portion **111** and on which no fusion bonding takes place, a first fusion-bonding portion **117**, which has a first fusion-welding length in a direction in which a tab is pulled out at the first end portion **111**, and chamfered portions **119**, which are positioned at both second-end-side corner portions **116** of the second end portion **112**, are provided. That is, according to the above configuration, even if vibrations are applied to the battery pack **800**, the second-end-side corner portions **116**, on which the chamfered portions **119** are formed, do not affect an adjacent unit battery **100**. Therefore, the leakage of electrolytic solution and other troubles do not occur, making it possible to provide a highly reliable battery pack **800**.

INDUSTRIAL APPLICABILITY

The present invention relates to a secondary battery pack such as lithium-ion battery that has been increasingly used in the field of power storage devices of mobile objects and other fields in recent years. Such a battery pack is made by connecting a plurality of unit batteries in series. The problem is that so far connection work is inefficient, and is low in productivity. According to the present invention, the battery pack of the present invention is made in such a way that pulled-out tabs of different polarities of a plurality of unit batteries are connected together on a board. Therefore, in producing the battery pack, work efficiency is high, resulting in an improvement in productivity. As a result, it is possible to achieve mass production and provide inexpensive secondary battery packs, and industrial applicability is very high.

EXPLANATIONS OF REFERENCE SYMBOLS

100 . . . unit battery
105 . . . electrode laminated area
110 . . . battery main unit
111 . . . first end portion
112 . . . second end portion
113 . . . side end portion
115 . . . first-end-side corner portion
116 . . . second-end-side corner portion
117 . . . first fusion-bonding portion
118 . . . second fusion-bonding portion
119 . . . chamfered portion
120 . . . positive-electrode pulled-out tab
125 . . . adding tab member
127 . . . hole
130 . . . negative-electrode pulled-out tab
137 . . . hole
200 . . . holder member
203 . . . pulled-out tab guide rib
210 . . . first surface
211 . . . first row
212 . . . second row
213 . . . pulled-out tab guidance section
214 . . . pulled-out tab guidance concave section

215 . . . pulled-out tab insertion hole
220 . . . pulled-out tab guide projecting section
221 . . . top section
222 . . . tapered side
230 . . . humping section
250 . . . second surface
251 . . . bridging structure section
255 . . . nut housing section
256 . . . nut
257 . . . pulled-out tab connection bolt
260 . . . divider piece
263 . . . positioning projection section
270 . . . screw hole
271 . . . board fixing screw
300 . . . board
314 . . . pulled-out tab guidance notch section
315 . . . pulled-out tab extraction hole
316 . . . pulled-out tab/divider piece extraction hole
317 . . . divider piece extraction hole
320*a*,**320***b*,**320***c* . . . thin-film electrode section
321 . . . metallic positive electrode washer
322 . . . metallic negative electrode washer
325 . . . pulled-out tab connection screw hole
328 . . . positioning hole
329 . . . board fixing screw hole
331,**332** . . . terminal member
340 . . . connector
400 . . . battery protective member
410 . . . flat-plate section
420 . . . notch section
421 . . . first notch section
422 . . . second notch section
423 . . . third notch section
440 . . . protection-side plate section
460 . . . two-sided adhesive tape
500 . . . battery connecting structure
504 . . . fourth cushioning member
505 . . . fifth cushioning member
530 . . . thermistor
600 . . . first case body
601 . . . first housing section
602 . . . second housing section
603 . . . circuit housing section
611 . . . discharge terminal attachment concave section
612 . . . charge terminal attachment concave section
613 . . . discharge terminal
614 . . . charge terminal
621 . . . first cushioning member
622 . . . second cushioning member
660 . . . second case body
661 . . . first housing section
662 . . . second housing section
663 . . . third cushioning member
673 . . . circuit housing section
700 . . . protective circuit board
800 . . . battery pack

The invention claimed is:

1. A battery pack, comprising:

a plurality of unit batteries that include a positive-electrode pulled-out tab and a negative-electrode pulled-out tab; and

a board on which pulled-out tab connection sections are formed to connect the pulled-out tabs of different polarities of adjacent unit batteries,

wherein the positive-electrode and negative-electrode pulled-out tabs of the unit battery, which is disposed on one end portion of the board, are both bent in the same direction.

2. A battery pack, comprising:

a plurality of unit batteries that include a positive-electrode pulled-out tab and a negative-electrode pulled-out tab; and

a board on which pulled-out tab connection sections are formed to connect the pulled-out tabs of different polarities of adjacent unit batteries,

wherein the positive-electrode and negative-electrode pulled-out tabs of the unit battery, which is disposed on one end portion of the board, are both bent in the same direction, and the positive-electrode and negative-electrode pulled-out tabs of the unit battery, which is disposed on another end portion of the board, are both bent in the same direction.

3. A battery pack, comprising:

a plurality of unit batteries that include a positive-electrode pulled-out tab and a negative-electrode pulled-out tab; and

a board on which pulled-out tab connection sections are formed to connect the pulled-out tabs of different polarities of adjacent unit batteries,

wherein the positive-electrode and negative-electrode pulled-out tabs of the unit battery, whose pulled-out tabs are connected by the pulled-out tab connection section, are bent in opposite directions.

4. A battery pack, comprising:

a plurality of unit batteries that include a positive-electrode pulled-out tab and a negative-electrode pulled-out tab; and

a board on which pulled-out tab connection sections are formed to connect the pulled-out tabs of different polarities of adjacent unit batteries,

wherein a divider piece is provided between the pulled-out tab connection sections, and the height of the divider piece from the board is higher than the height of a bolt used to connect pulled-out tabs in the pulled-out tab connection section.

5. A battery pack, comprising:

a plurality of unit batteries that include a positive-electrode pulled-out tab and a negative-electrode pulled-out tab;

a board on which pulled-out tab connection sections are formed to connect the pulled-out tabs of different polarities of adjacent unit batteries; and

a holder member that is fixed to the board and includes holes into which the positive-electrode and negative-electrode pulled-out tabs of a plurality of the unit batteries are inserted.

6. The battery pack according to claim **5**, wherein

guide projecting sections are provided on the holder member in such a way that the holes are sandwiched therebetween.

7. The battery pack according to claim **6**, wherein

tapered sides are provided on the guide projecting sections.

8. The battery pack according to claim **5**, wherein:

the pulled-out tabs of different polarities of adjacent unit batteries are connected in the pulled-out tab connection section with connection members; and

a plurality of the holes are provided on the holder member, and bridging structure sections are provided between a plurality of the holes.

9. The battery pack according to claim **8**, wherein

the connection members are bolts and nuts.

10. The battery pack according to claim **9**, wherein nut housing sections are provided in the bridging structure sections to house the nuts.

11. The battery pack according to claim **8**, wherein a divider piece, which is disposed between the pulled-out tab connection sections, is provided in the bridging structure section.

12. The battery pack according to claim **8**, wherein a positioning projecting section is provided in the bridging structure section and used to position the board and the holder member.

13. The battery pack according to claim **8**, wherein a screw hole, into which a fixing screw for fixing the board to the holder member is screwed, is provided in the bridging structure section.

* * * * *